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NOVEMBER 1962

*CENTRAL FOOD TECHNOLOGICAL
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HOME-SCALE PREPARATION OF FRUITS AND VEGETABLES (Revised edition) (*published in September, 1962*) Royal 8vo, P. 46. (*Editors:* J. V. Shankar, R. C. Bhutiani, H. C. Bhatnagar, A. Rahman, G. S. Siddappa and K. Indiramma).

This publication brings together under one cover the different methods of preparation and preservation of fruits and vegetables that can be practised on a domestic-scale together with the information about the equipment necessary and the places of their availability.

Methods of canning, bottling and drying of fruits and the preparation of jams, jellies, marmalades and syrups from them are described in general terms in addition to the descriptions, under each fruit, of the methods of their utilization with recipes for various products. Instructions for the different methods of processing vegetables are given under a separate head which is followed by those for making pickles, spiced carrot juice, ginger preserve and candy, and petha candy. A glossary gives the vernacular names of other fruits, vegetables and spices used in these preparations.

In short, the publication is designed for use by housewives, community development workers, home science students and cottage-scale manufacturers.

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NUTRITIONAL STUDIES ON SCREW-PRESS GROUNDNUT CAKE AND GROUNDNUT PROTEIN ISOLATE

By K. Anantharaman, N. Subramanian, D. S. Bhatia, M. Swaminathan, A. Sreenivasan and V. Subrahmanyan

(*Central Food Technological Research Institute, Mysore*)

Specially processed groundnut flour has been successfully used during recent years in India for the development of protein rich foods suitable for human consumption[1]. Work on the production, evaluation and utilization of isolated groundnut protein has also been in progress at this Institute for some years now[2, 3]. The protein isolate contains nearly twice as much protein as the flour and has a bland taste. It is free from fibre and is ideally suited for incorporation into processed foods suitable for feeding infants and children.

The processes that have been developed[4] for the preparation of the protein isolate have used as raw materials (*a*) screw-press (expeller) groundnut cake and (*b*) groundnut kernels. The recovery of fat from the alkaline dispersions of the material is accomplished by the use of centrifugal separators, yielding the protein isolate with a low fat content.

Nutritional studies on rats have shown that groundnut protein isolate possesses a satisfactory growth promoting value and protein efficiency ratio and that supplementation with the limiting amino acids, methionine and lysine, at optimum levels or admixture with good quality proteins, results in better utilization of the protein[5, 6]. The protein isolate has also been used in combination with casein and skim milk powder for the treatment of protein malnutrition in children[7]. The results presented in this paper provide additional data on the growth promoting value of the isolate as compared to the meal as well as different processed fractions obtained from the meal.

Experimental

Groundnut flour: Groundnut cake was obtained by pressing pre-cleaned decuticled groundnut kernels in a commercial expeller. The cake containing about 8 per cent nitrogen and 7 per cent fat was powdered in a flour mill to a mesh size of 20-42 (ASTM).

Acid-washed flour: Groundnut flour was dispersed in eight volumes of water and the pH adjusted to 4.5 with dilute hydrochloric acid. The dispersion was kept stirred for about 1 hour and then centrifuged. The supernatant (containing the soluble fractions—sugars, non-protein nitrogenous constituents, water soluble vitamins etc.) was discarded and the residue treated again with six volumes of water in a similar manner. The material was washed with water twice, mixed with dilute sodium hydroxide solution to bring the pH to 6.6 and finally freeze-dried.

Soluble solids from groundnut flour: The flour was dispersed in eight volumes of water and the pH adjusted to 9.0 with sodium hydroxide solution. After peptizing for 1 hour, the dispersion was centrifuged to remove the suspended solids and fat. The separated emulsion was adjusted to pH 6.6 and freeze dried.

Protein isolate: The isolation of protein from the flour was carried out according to the method described in a previous paper[4], but with variations in the meal: water ratio and pH of peptization. The dispersion was made, using eight volumes of water at pH 9.0 with a peptization period of one hour. This would enable a strict comparison of the quality of the isolate with that of the soluble solids which contain in addition the soluble non-protein nitrogenous constituents. The dispersion was centrifuged to remove suspended solids and fat; pH was then adjusted to 4.5 to precipitate the protein. The protein curd was centrifuged, washed, neutralised to pH 6.6 and freeze-dried. The yields of the different fractions and their contents of protein and fat are given in Table I.

Determination of protein efficiency ratio (*P.E.R.*)*:* The growth method of Osborne, Mendel and Ferry[8] was used for the determination of the

TABLE I. *Protein and fat content of processed groundnut fractions*

	Yield on raw material %	Protein (N × 6.25) %	Fat %
Groundnut flour ...	...	51.5	7.4
Acid-washed flour	68	63.6	5.3
Soluble solids fraction ...	47	73.1	1.2
Groundnut protein isolate ...	29	95.6	1.6

protein efficiency ratio at 10 per cent protein level in adequate basal diets. Female weanling rats, 28 days old, weighing on an average 45 g. were allotted to comparable groups as per randomized block design and fed *ad libitum* on the respective diets over a period of eight weeks. Groups of rats fed on casein and skim milk powder diets served as controls in the experiment. The diet was mixed with minimum amount of water to semi-fluid consistency, before administration. Weekly records of food consumption and body weight were maintained for each

TABLE II. *Protein efficiency ratio (P.E.R.) of processed fractions from groundnut flour*

(8 week experimental period; randomized block design; 8 female weanling rats per group)

Source of protein in the diet	Level of protein (N × 6.25) (%)	Four weeks					Eight weeks				
		Gain in wt. (g.)	Diet intake (g.)	Protein intake (g.)	P.E.R.		Gain in wt. (g.)	Diet intake (g.)	Protein intake (g.)	P.E.R.	
1. Groundnut flour	9.4	29.7	214.3	20.1	1.48	± 0.065 (48d.f.)*	65.6	503.2	47.2	1.39	± 0 039 (48d.f.)*
2. Acid-washed groundnut flour	9.4	35.7	235.3	22.1	1.61		71.9	526.9	49.6	1.45	
3. Soluble solids from groundnut flour ...	9.5	26.6	203.9	19.3	1.37		64.2	484.2	45.8	1.40	
4. Groundnut protein isolate ...	9.5	33.6	216.9	20.7	1.62		70.6	506.5	48.3	1.47	
5. Skim milk powder	9.4	64.5	251.9	23.6	2.73		103.1	565.1	53.0	1.95	
6. Casein† ...	10.0	67.4	251.8	25.2	2.68	± 0.070 (48d.f.)	100.1	527.0	52.8	1.90	± 0.043 (48d.f.)
Critical difference not involving group 6	at 5% level				... 0.18		...	...	...	0.11	
	at 1% level				... 0.25		...	...	...	0.15	
	at 0.1% level				... 0.32		...	...	...	0.20	
Critical difference involving group 6	at 5% level				... 0.19		...	...	...	0.12	
	at 1% level				... 0.26		...	...	...	0.16	
	at 0.1% level				... 0.34		...	...	...	0.20	

* Standard error of the mean for eight comparable groups; two groups not relevent for the discussion are excluded.

† One rat in this group died during the fifth week. The value for this rat has been estimated by the missing plot technique.

Basal diet contained (g./100 g.): corn starch 75, groundnut oil 10, sucrose 10, salts (Osborne and Mendel) 4 and vitaminised starch 1. The protein materials were incorporated at the expense of corn starch to provide the specified amount of protein in the diet. The fat content of the materials was taken into account in the preparation of the diets. Each g. of vitaminised starch contained thiamine 0.5 mg, riboflavin 1.0 mg, pyridoxine 0.4 mg, calcium pantothenate 4.0 mg, niacin 4.0 mg, choline chloride 150 mg, inositol 25 mg, para-amino benzoic acid 10 mg, vitamin B_{12} 2μg, biotin 0.02 mg, folic acid 0.2 mg and vitamin K 0.5 mg. The fat soluble vitamins were administered in groundnut oil base to provide 20 I.U. of vitamin A, 10 I.U. of vitamin D and 1 I.U. of vitamin E per rat per day.

individual rat and the protein efficiency ratio calculated for 4 and 8 week periods. The results are given in Table II.

Results and Discussion

On the basis of four weeks data it is seen that the P.E.R. values for groundnut flour, acid-washed flour and protein isolate are 1.48, 1.61 and 1.62 respectively, the differences between the values being not significant. The soluble solids fraction has, however, given a lower value of 1.37, being statistically significant at 1 per cent level, as compared to the other values. It is seen that the diet consumption in this group is also somewhat lower. The isolated protein has given a slightly higher value (1.62) for the P.E.R. as compared to that of the meal (1.48), though the diet consumption in the two groups is nearly the same, being 214 g. and 217 g. respectively during the period.

At the end of eight weeks the protein efficiency ratios of groundnut flour, acid-washed flour, soluble solids and protein isolate, are 1.39, 1.45, 1.40 and 1.47 respectively. The results clearly show that the isolated protein is as good as the meal as regards protein quality and that the removal of non-protein nitrogenous constituents as in the case of acid-washed flour or protein isolate has not resulted in any lowering in the nutritive value of the protein. Actually, the elimination of acid-soluble constituents from the meal by washing at the isoelectric pH has resulted in a slight improvement in the P.E.R. though this is not significant, statistically. The diet consumption and gain in weight of rats fed the acid-washed flour are more than in the case of the meal. The other two fractions *viz.*, soluble solids and protein isolate differing with respect to the presence or absence of acid-soluble constituents have also shown a similar trend in the results. If these data are confirmed, using larger number of animals, it would indicate either the inadequacy of the non-protein nitrogenous fraction to support growth comparable to the protein fraction or the presence of a weak tryptic[9,10] or growth inhibitor.

Summary

1. Screw-press groundnut flour of edible quality and processed fractions obtained from it have been compared in a growth study using female rats.

2. The protein efficiency ratio of acid-washed flour, soluble solids and protein isolate are comparable to that of the meal, the values ranging between 1.39 and 1.47 at the end of eight weeks as compared to a value of 1.90 for casein and 1.95 for skim milk powder.

3. The two fractions, acid-washed flour and protein isolate, which are free from the acid-soluble constituents have been found to possess a slightly higher growth promoting value and P.E.R. as compared to the meal and the soluble solids fraction, respectively. The significance of this result is discussed.

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EFFECT OF DIFFERENT METHODS OF DRYING ON THE NUTRITIVE VALUE OF GROUNDNUT PROTEIN ISOLATE

By N. Subramanian, K. Anantharaman, Kantha Joseph, M. Narayana Rao, D. S. Bhatia
M. Swaminathan, A. Sreenivasan and V. Subrahmanyan
(Central Food Technological Research Institute, Mysore)

In the processes developed at this Institute for the production of edible groundnut protein isolate from the kernel or screw-press cake, the centrifuged wet protein was dried in a shelf drier in a current of hot air at 50-60°C for 24 hours to get the dried product[1,2]. Though the wet protein isolate was holding relatively less amount of water than the carbohydrate meal fraction, it was more difficult to handle and dry because of its sticky nature. During the first few hours of the drying period, the material softened, became brown on the surface and exuded some quantity of free water, after which it dried slowly. Though this method of drying the protein gave a product with a high solubility it was not practicable for the large scale production. Preliminary de-watering of the protein curd on a double drum drier resulted in a product which could be easily granulated and dried in a shorter period. The isolate could also be drum-dried completely, thus finishing the drying operation in a single stage.

In a study of some of the operations in the integrated process for groundnut, Eapen and Kalbag reported that the wet protein isolate was stable without undergoing much denaturation, upto 1 hour at 60°C in the wet state or upto 3 hours at 100°C in the dry state[3]. Among the different methods of drying, only drum-drying was found to reduce the solubility of protein to a considerable extent. Using the flaked raw groundnut kernels and solvent extracted meal in their study, Fontaine *et al.*, found that the critical denaturing temperatures for the protein were above 118°C at 0 per cent R.H. (dry heat) and above 80°C at 100 per cent R.H.[4]. Lord and Wakelam studied the changes occurring in the proteins as a result of processing groundnut under selected industrial conditions and found that the loss of protein solubility in severely steamed, solvent extracted meal was accompanied by chemical breakdown involving destruction of some sulphur containing fragments[5]. Cama and Morton evaluated these samples and showed that exposure to high temperatures in the presence of steam, significantly reduced the nutritive value of the protein[6]. Since wet heating of the isolate on the drum drier for either partial de-watering or complete drying reduced the solubility of the product, it was of interest to ascertain whether such methods of drying had also any adverse effect on the growth promoting value of the protein.

Experimental

Groundnut protein isolate was prepared from edible quality screw-press cake, according to the method described in an earlier publication[7]. In the present work, however, the meal: water ratio was kept at 1:12 using 8 volumes initially for the peptization at pH 8.5 and 4 volumes later for washing the sieve residue, instead of a single extraction of the meal with 15 volumes of alkaline water. The wet isoelectric protein, containing 60-65 per cent water after centrifugation, was divided into lots and dried under different conditions as follows:

(A) Completely air-dried at 49°C for 24 hours.

(B) Completely drum-dried at atmospheric pressure (steam pressure—60 lb. per sq. in.). The wet protein mass fed between the rolls attained a temperature of 95-100°C during drying.

(C) Partially de-watered on the drum drier to reduce the moisture content to about 40 per cent, granulated and air-dried at 49°C for 16 hours.

It was found that toasting of air-dried isolate at 115°C for 12-15 minutes gave an agreeable flavour to the product. This was done in a frying pan taking care to avoid charring of the product during the operation. The toasted sample (D) was included for the assay.

Solubility studies on protein isolates: The solubility of protein in the different specimens was determined in the pH range 5.5 to 8.5 by shaking 2.5 g. of the sample in 100 cc. water containing different quantities of dilute sodium hydroxide solution. After equilibration for one hour, the solutions were centrifuged and the supernatants analysed for nitrogen. The degree of peptization at pH 7.5 as obtained from the solubility curves is given in Table I.

TABLE I. *Solubility of groundnut protein isolates (isoelectric) dried under different conditions*

Sample	Method of drying	Solubility* (%)
A	Air-dried at 49°C ...	95.5
B	Drum-dried ...	41.0
C	Partially drum-dried and finally air-dried ...	82.0
D	Air-dried and toasted at 115°C for 12-15 minutes ...	90.0

* Percentage of protein in sample peptized in water at pH 7.5.

Determination of protein efficiency ratio: The air-dried (A), drum-dried (B) and partially drum-dried (C) samples were compared to assess their growth promoting value, using male rats; the toasted sample (D) was compared with the air-dried protein isolate using female rats. Commercial lactic casein served as control in the studies. The samples of isolate containing 92-95 per cent protein were incorporated in adequate basal diets to provide the equivalent of 1.6 per cent nitrogen and fed *ad libitum* to comparable groups of animals. Data on the diet and protein consumption, gain in weight and the protein efficiency ratio for 4 and 8 weeks on the different diets are given in Table II. The changes in the P.E.R. values at different stages have also been graphically presented in Fig. 1.

Net protein utilization values of air-dried and drum-dried protein isolates: The net protein utilization values (N.P.U.) of air-dried and drum-dried isolates as compared to casein were determined on young male rats by the method of Bender[8], at 10 per cent protein level in the diet. Rats weighing about 47 g. each were allotted to four groups on the basis of strict litter-mates and fed on the experimental diets for a period of ten days; one of the groups received nitrogen-free diet during the period. The animals were sacrificed at the end of the experimental period, the intestinal contents removed and the carcass minced and dried to constant weight at 90-95°C, using alcohol to facilitate drying. The body nitrogen was determined on the dried material and the N.P.U. values were calculated by applying the equation:

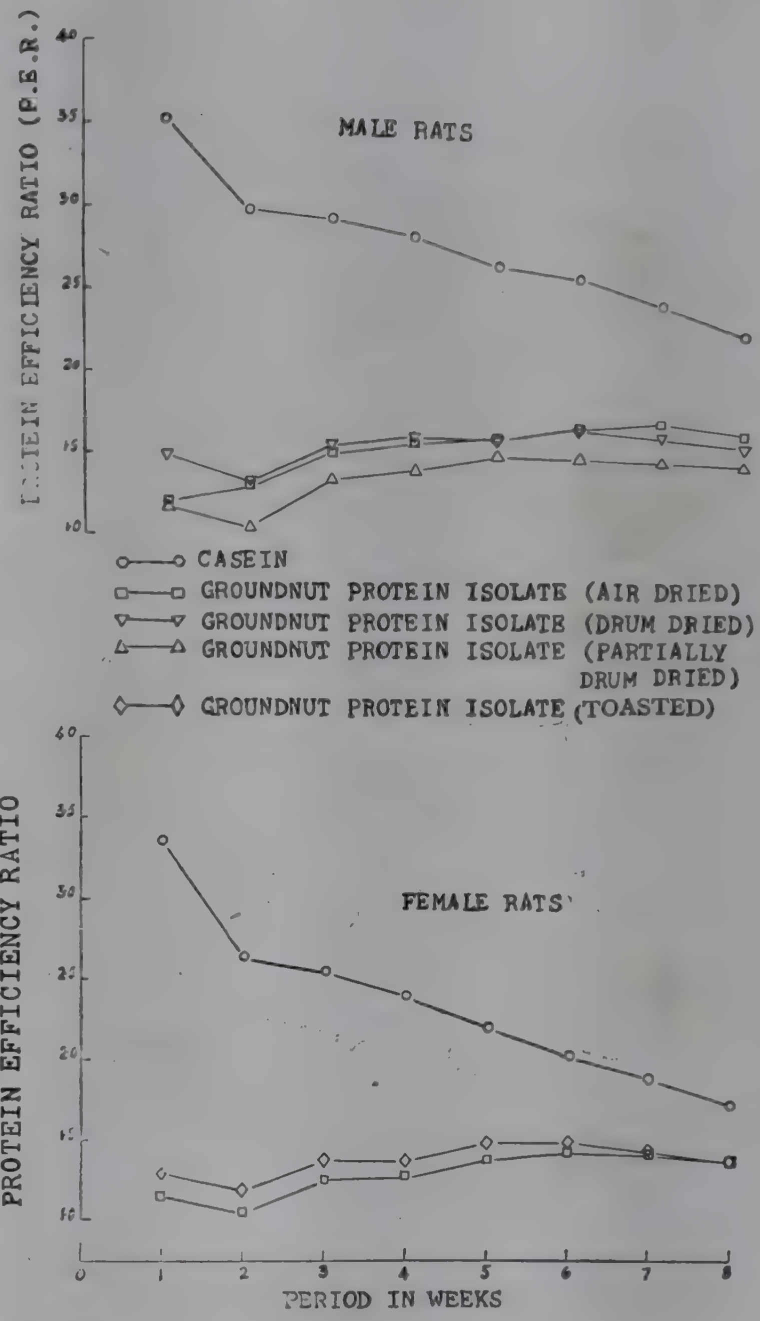

FIG. 1. Protein efficiency ratio of casein and groundnut protein isolates (10% protein in diet.)

TABLE II. *Protein efficiency ratio (P.E.R.) of casein and groundnut protein isolates dried under different conditions*
(8-week experimental period; randomized block design)
Groups 1-4 7: male weanling rats per group, initial weight 45 g.
Groups 5-7 7: female weanling rats per group, strict litter mates; initial weight 45 g.

Group	Source of protein in the diet	Level of protein (N × 6.25) (%)	Four weeks: Gain in wt. (g.)	Four weeks: Diet intake (g.)	Four weeks: Protein intake (g.)	Four weeks: P.E.R.		Eight weeks: Gain in wt. (g.)	Eight weeks: Diet intake (g.)	Eight weeks: Protein intake (g.)	Eight weeks: P.E.R.	
1	Casein	10.5	78.7	264.2	27.8	2.81	±0.044* (18 df)	131.7	566.8	59.7	2.19	±0.045* (18 df)
2	Groundnut protein isolate, air-dried (A)	10.2	31.7	199.2	20.3	1.56		73.7	449.9	45.8	1.61	
3	Groundnut protein isolate, drum-dried (B)	10.4	34.1	203.8	21.2	1.60		72.4	455.8	47.5	1.53	
4	Groundnut protein isolate, partially drum-dried (C)	10.2	27.9	196.0	20.0	1.39		61.9	429.9	43.8	1.41	
5	Casein	10.5	61.1	243.6	25.7	2.38	±0.065 (12 df)	92.1	510.1	53.8	1.71±0.056	
6	Groundnut protein isolate, air-dried (A)	10.2	26.4	202.1	20.6	1.27		63.3	454.8	46.3	1.36±0.062†	
7	Groundnut protein isolate, toasted (D)	10.8	31.1	209.8	22.6	1.37		69.1	472.6	50.9	1.36±0.056	

Critical difference at	Four weeks: 5%	1%	0.1%		Eight weeks: 5%	1%	0.1%
Groups 1-4	0.132	0.181	0.247		0.134	0.184	0.251
Groups 5-7	0.200	0.281	0.397	5~7	0.174	0.245	0.351
				5~6 6~7	0.184	0.261	0.373

* Standard error of the mean.

† One rat in group 6 escaped during the eighth week. The P.E.R. value for this rat for eight week period was estimated by the missing plot technique.

Basal diet contained (g/100 g.): corn starch 75, sucrose 10, groundnut oil 10, salts 4 (Osborne & Mendel) and vitaminised starch 1. The protein isolates were incorporated in the diets at the specified levels at the expense of corn starch. Each g. of vitaminised starch contained the following: thiamine 0.5 mg., riboflavin 1.0 mg., pyridoxin 0.4 mg., calcium pantothenate 4.0 mg., niacin 4.0 mg., choline chloride 100 mg., inositol 25 mg., para-amino benzoic acid 10 mg., vitamin K 0.5 mg., biotin 0.02 mg., folic acid 0.2 mg., and vitamin B_{12} 2 μg. Adexolin liquid containing 12,000 I.U. of vitamin A and 2,000 I.U. of vitamin D_2 per ml. was added to the diet to meet the essential requirements of the rat. The dry diets were weighed into individual cups and mixed with minimum amount of water to semi-fluid consistency before feeding.

$$\text{N.P.U.} = \frac{\text{Body N of test group—body N of non-protein group} + \text{N consumed by non-protein group}}{\text{N consumed by test group}}$$

The results are presented in Table III.

Nitrogen balance studies: The true digestibility co-efficient and biologial value of both the air-dried and drum-dried samples were determined on groups of growing adult male rats weighing about 150 g. each, at 10 per cent protein level in diet. Commercial lactic casein was used for comparison. The data are presented in Table IV.

Results and Discussion

Data on the peptizability of protein in the isolates dried under different conditions show that the air-dried specimen possessed the maximum solubility, indicating minimum denaturation of proteins. The drum-dried sample was peptizable to the extent of only 41 per cent of the total nitrogen at pH 7.5, while the partially drum-dried sample gave a value of 82 per cent. Toasting of air-dried specimen for about 15 minutes at 115°C did not lower the solubility

TABLE III. *Net protein utilization (N.P.U.) of casein and groundnut protein isolates* (10 days experimental period; randomized block design; 5 male rats per group, strict litter-mates; initial weight 47 g.)

Source of protein in the diet	Level of protein (N×6.25) (%)	Gain in wt. (g.)	Diet intake (g.)	Protein intake (g.)	N.P.U. value	
Casein	10.5	23.8	85.8	9.0	63.4	
Groundnut protein isolate, air-dried (A)	10.2	10.2	79.5	8.1	37.7	±2.92* (8d.f.)
Groundnut protein isolate, drum-dried (B)	10.4	13.0	77.7	8.1	46.1	

Critical difference at 5% level ... 9.5
,, ,, at 1% level ... 13.9
,, ,, at 0.1% level ... 20.8

*Standard error of the mean.

appreciably. These results, generally confirm the earlier findings that dry heat is less damaging than wet heat as regards the peptization characteristics of groundnut protein.

The results presented in Table II show that the average food consumption as well as gain in weight of rats fed on casein diet are significantly higher than in any of the other groups. The air-dried and drum-dried isolates have promoted nearly the same gain in weight in male rats with comparable values for the diet and protein consumption. The food consumption and gain in weight of rats fed on the partially drum-dried sample were somewhat lower than in the other two cases. The differences in the P.E.R. values of air-dried and drum-dried isolates are not statistically significant during the entire period of the experiment, even though the drum-dried sample has shown a slightly better response during the four week period. Toasting of the air-dried protein isolate at 115°C for 15 minutes has not adversely affected protein quality as seen in the case of female rats, the P.E.R. values being 1.36 in both the cases at the end of eight weeks. The diet intake and gain in weight of animals on the toasted protein diet are, however, slightly more throughout the experimental period.

The changes in the P.E.R. values on the different diets as represented in Fig. 1, show that the animals fed on groundnut protein isolate have exhibited a gradual improvement with respect to protein utilization after the first two weeks with slight decrease in the P.E.R. towards end of the experimental period. Rats fed on casein diet, on the other hand, showed a marked decrease in the P.E.R. at the end of the second week as compared to the first week, and registered a gradual lowering in the utilization of protein at later stages.

The average net protein utilization values for casein, air-dried groundnut protein and drum-

TABLE IV. *Digestibility co-efficient and biological value of casein and groundnut protein isolates* (6 male rats per group: average body weight 150 g.)

Source of protein in diet	Level of protein (N×6.25)	Digestibility co-efficient		Biological value	
A. Casein (control)	10.5	97.4±1.02*		80.9±1.01*	
B. Groundnut protein isolate, air-dried (A)	10.2	94.5±1.16	(11 d.f.)	56.9±1.15	(11 d.f.)
C. Groundnut protein isolate, drum-dried (B)	10.4	95.2±1.02		59.8±1.01	

	A∼B	A∼C B∼C	A∼B	A∼C B∼C
Critical difference at 5% level	3.22	3.45	3.19	3.42
,, ,, at 1% level	...	...	4.53	4.86
,, ,, at 0.1% level	...	...	6.56	7.03

* Standard error of the mean.

dried protein are 63, 38 and 46 respectively (Table III) the difference between the last two figures being statistically not significant due to the small number of observations made, as well as large variability in the values. The present values compare well with those of 60 for casein and 43 for groundnut meal reported by Miller and Bender[9]. As observed in the P.E.R. studies the drum-dried sample has given a better response in the present short term experiment with respect to N.P.U.

The biological values of air-dried protein and drum-dried protein as determined on growing adult rats are 56.9 and 59.8 respectively, the difference between the values being statistically not significant. The true digestibility co-efficients of the two samples are about 95 per cent. The values obtained in the present experiment for the biological value of casein and air-dried groundnut protein isolate are somewhat higher than those reported earlier.[10]

The results obtained in the different experiments show that the growth promoting value and utilization of the isolated groundnut protein have not been adversely affected, to any considerable extent, by the different methods employed for drying the wet isolate.

Summary

1. Groundnut protein isolate obtained from edible quality screw-press cake was dried under different conditions and the samples were assayed for their nutritional value by the growth and nitrogen balance methods on rats.

2. Complete drying of the wet isoelectric protein in shelf-drier or drum-drier did not result in any significant difference in the over-all growth promoting value and protein efficiency ratio of the samples. Short period toasting of the air-dried protein did not also result in any deterioration in the protein quality.

3. There was no correlation between the protein solubility of the samples and growth promoting value.

4. The values obtained for the net protein utilization (Bender), true digestibility co-efficient and biological value of the air-dried and drum-dried protein isolates were comparable.

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STUDIES ON THE PREPARATION AND SHELF-LIFE OF A SPRAY-DRIED INFANT FOOD COMPOSITION BASED ON GROUNDNUT PROTEIN ISOLATE AND SKIM MILK POWDER

By V. Subrahmanyan, M. R. Chandrasekhara, N. Subramanian, Soma Korula*, D. S. Bhatia, A. Sreenivasan and M. Swaminathan

(Central Food Technological Research Institute, Mysore)

Infant foods used in different parts of the world are generally prepared from cow's or buffalo milk[1,2]. In view of the acute shortage in the production of milk in several technically under-developed countries, considerable interest has recently been evinced by several workers on the preparation of dried infant foods based on soyabean and groundnut[3-6]. Dean[3] has described a process for the preparation of spray-dried malt food containing soyabean. Spray-dried milk substitutes like 'Soyalac' or 'Mullsoy' are being manufactured in America[1,4]. A product known as 'Saridele' suitable for child feeding is being prepared from a blend of soyabean and sesame in Indonesia with UNICEF aid[5]. Shurpaleker *et al.*[6] reported that a spray-dried vegetable milk substitute from a blend of soyabean and groundnut milks possessed high nutritive value as judged by growth experiments on albino rats and that the nutritive value of a blend of vegetable milk substitute and a milk food was nearly equal to that of milk food having a similar composition. The present paper deals with the preparation of a spray-dried infant food formula based on groundnut protein isolate and skim milk powder with added dextri-maltose, fat, minerals and vitamins.

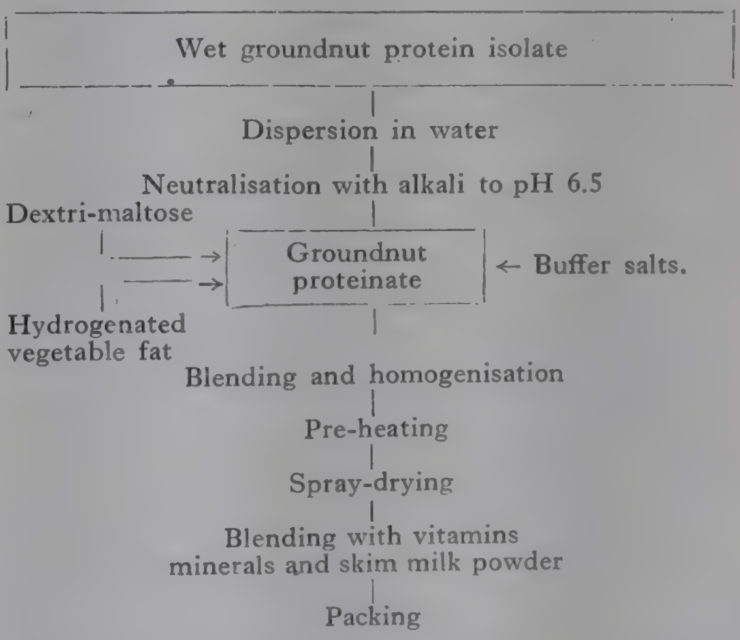
Experimental

Materials: Groundnut protein isolate used in this experiment was prepared from expeller cake according to Anantharaman *et al.*[7] The wet protein containing about 60 per cent moisture was preserved in deep freeze and used in the preparation of infant food composition. Spray-dried skim milk powder† and dextri-maltose‡ were obtained from commercial firms. A proprietary brand of hydrogenated groundnut oil was used as the source of fat.

Process of manufacture: The flow sheet of the process is outlined in Fig. 1 and the process is briefly described below:

Fig. 1

Flow sheet of the process for the preparation of a substitute infant food based on isolated groundnut protein


Wet groundnut protein isolate
Dispersion in water
Neutralisation with alkali to pH 6.5
Dextri-maltose
Groundnut proteinate
← Buffer salts.
Hydrogenated vegetable fat
Blending and homogenisation
Pre-heating
Spray-drying
Blending with vitamins minerals and skim milk powder
Packing

Peptisation of groundnut protein: The wet protein was dispersed in the required amount of water by the addition of alkali so that the pH of the dispersion was about 6.5—6.6. The mixture was mechanically agitated for about 15 minutes to disperse the protein. Buffer salts were added so that the final pH of the dispersion was about 6.4—6.5.

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* Unichem Research Fellow.

† From Kaira District Co-operative Milk Producers Union, Anand.

‡ From Raptokos Brett and Co. Ltd., Bombay.

Addition of dextri-maltose, fat and homogenisation: Dextri-maltose and melted hydrogenated fat were added in sufficient amounts to the protein dispersion so that the fat and protein contents of the spray-dried powder were about 24 and 23 per cent respectively. The blend was then homogenised.

Pasteurisation and spray-drying: The blend was pasteurised and spray-dried. The temperature of the inlet air for spray-drying was about 380°-390°F and that of the outlet air was about 200-210°F. The powder was collected in clean tins provided with air-tight lids.

Fortification with minerals and vitamins and admixture with skim milk powder: The resulting product was mixed with skim milk powder in the ratio of 3:1 so that the blend contained about 26 per cent protein and 18 per cent fat. The product was fortified with a salt mixture so that the mineral content of the product was about the same as that present in full-fat milk powder from cow's milk. The salt mixture also contained ferrous ammonium citrate to meet the iron requirements of the infant. The vitamins were added in the form of a dry premix to bring the vitamin content of the final product to that of whole milk powder. The fortified food was packed under nitrogen in tins (500 g. per tin) provided with tagger tops and lever lids.

Chemical composition and shelf-life: The chemical composition of the final product was determined by A.O.A.C. methods[8]. The standard plate count of the product was determined according to the methods of the American Public Health Association[9].

The solubility of the product was determined according to Howat *et al*[10] and was always corrected for the moisture content of the powder.

The food was packed in seamed lacquered tin cans (8 oz.) in nitrogen according to the method of Chandrasekhara *et al*[11]. The oxygen content of the gas in the can determined according to Lea *et al*[12]., was about 4 per cent. The cans were stored at three different temperatures *i.e.*, room temperature (25°-29°C), 37°C and 45°C. Two cans from each lot were examined at monthly intervals for colour, solubility, peroxide value and T.B.A. value, vitamins A and C and organoleptic quality according to the methods used by Chandrasekhara *et al*[11,13].

Results and Discussion

Table I shows that the infant food formula contained 26.2 per cent protein and 18.4 per cent fat. Two thirds of the protein is derived from groundnut and one third from milk. The chemical composition of the product is in accordance with the Indian standard for infant milk food[14].

TABLE I. *Chemical composition* of infant food based on groundnut protein isolate* (values per 100 g.)

Moisture (g) ...	2.8
Protein (g) ...	26.2
Fat (g) ...	18.4
Ash (g) ...	5.3
Carbohydrate (g), (by diff.) ...	47.3
Calcium (g) ...	0.95
Phosphorus (g) ...	0.73
Vitamin A (I U.) ...	1500
,, D (I.U.) ...	400
,, E (mg) ...	5.0
Thiamine (mg) ...	0.9
Riboflavin (mg) ...	1.5
Niacin (mg) ...	6.0
Pyridoxine (mg) ...	0.6
Calcium pantothenate (mg) ...	3.8
Folic acid (mg) ...	0.1
Vitamin B_{12} (μg) ...	2.2
Inositol (mg) ...	150
Choline (mg) ...	130
Biotin (μg) ...	3.5

* The added amounts of vitamins are given in the table except in the case of vitamin A, thiamine, riboflavin and niacin which were assayed.

TABLE II. *Effect of storage on quality of spray-dried infant food formula based on groundnut protein isolate*

Storage temperature ...	...	R.T. (25°-29°C)	37°C
Period of storage	Initial	7 months	7 months
Organoleptic quality ...	Acceptable	Acceptable	Acceptable
Colour of powder	Grey white	Grey white	Grey white
Solubility ...	89	88	88
Peroxide value*	0.5	2 0	2 5
T.B.A. value†	0.03	0.06	0.10
Vitamin A. I.U./100 g. ...	1500	1161	1044
Vitamin C. mg/100 g.	30	24.0	20

* Expressed as milliequivalent of oxygen per kg. of powder.

† Expressed as optical densities.

The total plate count of the product was 26,000 per gram which is less than the limits prescribed in the Indian standard. The product was free from *B-coli*, *Salmonella* and anaerobic pathogens.

The losses of vitamin A in samples stored for 7 months at room temperature and 37°C were about 23 per cent and 30 per cent, and of vitamin C about 20 per cent and 33 per cent respectively. The solubility of the product in water at 60°C ranged from 88 to 90 per cent and did not change appreciably as a result of storage for 7 months at 37°C. The samples stored at 45°C developed a brown colour after 3 months' storage and hence were not analysed. There were some increases in the peroxide value and T.B.A. values of the fat in the samples stored at room temperature and 37°C. Samples stored for 7 months at room temperature and at 37°C were acceptable to the tasters.

Summary

1. An infant food composition containing about 26 per cent protein and 18 per cent fat has been prepared from a spray-dried blend of groundnut protein isolate, dextri-maltose, hydrogenated vegetable fat and skim milk powder; it has been fortified with essential minerals and vitamins.

2. The product had a low total plate count and was free from *B-coli*, *Salmonella* and anaerobic pathogens. The food reconstituted readily in warm water yielding a milk-like product. The product was organoleptically acceptable when evaluated at the end of 7 months' storage at room temperature and at 37°C.

Acknowledgment

Authors are thankful to Messrs Raptakos Brett & Co., Bombay for providing all facilities for spray-drying of the product.

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NUTRITIVE VALUE OF INFANT FOOD COMPOSITION BASED ON GROUNDNUT PROTEIN ISOLATE AND SKIM MILK POWDER

By Soma Korula*, M. R. Chandrasekhara, A. N. Sankaran, D. S. Bhatia,
M. Swaminathan, A. Sreenivasan and V. Subrahmanyan

(Central Food Technological Research Institute, Mysore)

Dried infant food compositions based on soyabean have been used successfully by some workers for feeding infants[1,2]. In an earlier publication, a process for the preparation of a spray-dried infant food composition based on groundnut protein isolate and skim milk powder was described.[3] The present paper relates to studies on the nutritive value of the infant food composition as compared with a milk food of similar composition (prepared by blending 70 parts of whole milk powder, 22 parts of skim milk powder and 8 parts of cane sugar).

Experimental

Analytical: The chemical compositions of the milk food and the infant food as determined by A.O.A.C. methods[4] are given in Table I. The essential amino acid make-up as determined according to the methods used by Krishnamurthy *et al.*[5] is given in Table II.

Animal experiments: PROTEIN EFFICIENCY RATIO: The protein efficiency ratios (P.E.R) of the proteins of infant food composition and milk food were determined at four levels of protein intake (10, 15, 20 and 25 per cent) by the growth method of Osborne, Mendel and Ferry[6]. The experiment was conducted in three series. Groups of male albino rats weighing about 45g. (distributed according to body weight and litter mates in a randomized block design) were used in the experiments. The composition of the experimental diets are shown in Table III. Records of food intake and weekly increase in

TABLE I. *The chemical composition of infant food[1] composition and milk food[2]* (values per 100g)

Constituents	Infant food composition	Milk food
Moisture (g)	2.8	2.9
Protein[3] (g)	26.2	26.6
Fat (g)	18.4	18.5
Ash (g)	5.3	5.5
Carbohydrates (g) (by diff)	47.3	46.5
Calcium (g)	0.95	1.04
Phosphorus (g)	0.73	0.92
Vitamin A (I.U.)	1,500	1,360
Thiamine (mg)	0.9	0.52
Riboflavin (mg)	1.5	1.46
Niacin (mg)	6.0	1.2

[1] The infant food composition contained added vitamins A, D, E, pyridoxine, calcium pantothenate, folic acid, vitamin B_{12}, inositol, choline and biotin.

[2] The other B-vitamins present in milk food were not assayed.

[3] Obtained by multiplying nitrogen content by 6.25 for vegetable milk and 6.38 for milk food.

TABLE II. *The essential amino acid content of infant food composition and milk food*
(amino acids g/16 g.N)

Amino acid	Infant food composition	Milk food	FAO reference protein pattern[1]
Arginine	8.2	4.1	...
Cystine	1.3	0.9	...
Histidine	2.6	2.6	...
Isoleucine	4.8	6.4	4.2
Leucine	7.2	10.6	4.8
Lysine	5.2	8.1	4.2
Methionine	1.4	2.8	2.2
Methionine + cystine	2.7	3.7	4.2
Phenylalanine	5.1	5.5	2.8
Threonine	3.5	4.6	2.8
Tryptophane	1.2	1.4	1.4
Valine	5.6	6.8	4.2

[1] *Protein requirements*—Report of the FAO Committee, published by Food and Agriculture Organisation, Rome, 1957.

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* Unichem Research Fellow.

TABLE III. *Percentage composition of experimental diets* used for protein efficiency ratio*

Ingredients	Diets I & II (protein 10%)	Diets III & IV (protein 15%)	Diets V & VI (protein 20%)	Diets VII & VIII (protein 25%)
Infant food composition or milk food ...	38.5	57.8	77.0	95.0
Corn starch ...	58.0	38.7	19.5	1.5

* Other ingredients common to all diets were as follows: Salt mixture (McCollum & Davis) 2.0; Vitaminised starch 1.0; and Shark liver oil 0.5.

body weight were maintained for each animal. The experiment lasted for a period of 4 weeks. The results are presented in Table IV.

OVERALL NUTRITIVE VALUE OF INFANT FOOD COMPOSITION AND MILK FOOD: Two groups of freshly weaned albino rats, (6 males and 6 females per group, distributed equally according to body weight and litter-mate) were used. The animals were housed in individual cages with raised wire-screen bottoms and fed on the foods reconstituted in six times their weight of warm water. Records of the daily food intake and weekly increase in body weight of animals were maintained. At the end of 8 weeks feeding, the haemoglobin and red blood cell count were determined according to Shurpaleker *et al.*[7] The male animals were then sacrificed and the livers and carcasses were analysed for moisture, protein and fat according to the methods used by Shurpaleker *et al*[7]. The mean protein content of the carcass for a group of weanling rats (weighing about 45 g.) was determined. Using this data, the retention of protein in the different groups of the experimental animals over a period of 8 weeks was calculated. The results are presented in Tables V—VII.

Results and Discussion

Protein efficiency ratio (P.E.R): The results in Table IV show that the P.E.R of the proteins of infant food composition (2.33) was significantly less than that of the proteins of milk food (3.42) at 10 per cent level of protein intake; but at 15, 20 and 25 per cent levels of protein intake, at which such foods are normally used for infant

TABLE IV. *Protein efficiency ratio of the proteins of infant food composition and milk food*
(Period of each series of the experiment: 4 weeks)

Source of protein in diet	No. of male rats per group	Level of protein (%)	Initial body weight (g)	Average gain in body wt. (g)	Average protein intake (g)	Average P.E.R.	Critical difference at different levels		
							5%	1%	0.1%
Series I									
Infant food composition ...	7	10	42.9	52.7	22.61	2.33 ±0.053	...	...	0.45
Milk food ...	,,	,,	42.4	80.0	23.44	3.42 (6 d.f.)			
Series II									
Infant food composition ...	8	15	41.7	107.6	49.47	2.17 ±0.059	0.17	...	...
Milk food ...	,,	,,	42.9	96.5	43.15	2.21 (49* d.f)			
Infant food composition ...	,,	20	42.9	114.5	60.69	1.89 ±0.059	0.17	...	...
Milk food ...	,,	,,	42.6	93.6	52 03	1.80 (49* d.f)			
Series III									
Infant food composition ...	6	25	46.0	101.0	60.95	1.66 ±0.063	0.23	...	...
Milk food ...	,,	,,	46 2	88.3	53.5	1.65 (5 d.f.)			

* Data from an experiment which included 8 groups of 8 animals each.

TABLE V. *Average weekly increase in body weight of rats fed on infant food composition and milk food*
(Duration of experiment: 8 weeks) (Average values for 6 males and 6 females per group)

Group no.	Diet	Initial body wt. (g)	Daily food intake (g) (on dry basis)	Weekly gain in body wt. (g)		Feed efficiency ratio		Haemoglobin (g/100 ml)		Red blood cells (10^6/c.mm.)	
A	Infant food composition	45.6	9.2	17.84	±0.46 (10 d.f.)	0.271	±0.005 (10 d.f.)	16.11	±0.17 (10 d.f.)	7.70	±0.15 (10 d.f.)
B	Milk food	45.7	8.5	15.84		0.260		16.4		7.89	
	Critical difference at 5% level			1.45		0.016		0.5		0.46	
	,, ,, 1% ,,			2.07		—		—		—	

TABLE VI. *Mean chemical composition of liver and carcass of rats fed on infant food composition and milk food*
(Duration of experiment: 8 weeks; Mean values for 6 male rats per group)

Diet	Mean body weight (g)		Liver						Carcass					
	Initial	Final	Moisture %		Protein %		Fat %		Moisture %		Protein %		Fat %	
Infant food composition	46.0	225·2	70·0	±0.18 (5 d.f.)	19.48	±0.37 (5 d.f.)	3·39	±0.06 (5 d.f.)	57.47	±0·45 (5 d·f·)	18.92	±0.29 (5 d.f.)	19.1	±0.47 (5 d·f.)
Milk food	46.0	201·2	69·5		20.74		3·24		57.99		19.38		17.8	
Critical difference at 5% level			0.7		1.36		0.23		1.63		1.05		1.70	

feeding, there were no significant differences in the P.E.R of the proteins of infant food composition and milk food.

Growth and composition of blood: Table V shows that the average weekly growth of rats fed on the infant food composition (17.8 g.) was slightly greater than that observed with milk food (15.8 g). There was no significant difference, however, in the feed efficiency ratio of the two foods. The mean haemoglobin content and red blood cell count in the blood of animals fed on the two foods were nearly the same.

Composition of liver and carcass. Table VI shows that there were no significant differences in the mean protein and fat contents of the livers of rats fed on the two foods. The mean protein content of the carcass of rats fed on the milk food was, however, slightly higher than that of rats fed on infant food composition. Table VII indicates that there was no significant difference in the mean protein retention in the two groups of rats.

It has been shown that an infant food composition based on groundnut protein isolate and skim milk powder (containing 2 parts of groundnut protein and one part of milk protein) and fortified with essential vitamins and minerals possesses high nutritive value comparing well with that of a milk food of similar composition. These findings are of considerable importance to several tropical and sub-tropical countries in which there is an acute shortage of milk. Blending of spray-dried food based on groundnut protein isolate with skim milk powder will help to

TABLE VII. *Intake and retention of protein in rats fed on infant food composition and milk food*
(Duration of experiment: 8 weeks; mean values for 6 male rats in each group)

Diet	Total protein intake (g)	Total increase in body weight (g)	Total body protein (g)	Initial body protein* (g)	Protein retained (g)	Protein retained per 100 g. increase in body weight (g)	
Infant food composition ...	143.7	179.2	42.69	8.10	34.59	19.26	± 0.36 (5 d.f.)
Milk food ...	132.6	155.2	38.97	8.10	30.87	19.91	
			Critical difference at 5% level			1.30	

* Initial body protein determined separately for a group of 6 male weanling rats weighing about 46 g. each.

extend the use of available skim milk powder for the feeding of infants. Feeding trials with infants are being planned.

Summary

1. The nutritive value of an infant food composition based on groundnut protein isolate, dextri-maltose, hydrogenated vegetable fat and skim milk powder and fortified with vitamins and minerals as compared with a milk food has been studied using albino rats.

2. The protein efficiency ratio of the proteins of the infant food composition (2.33) was significantly less than that of milk food (3.42) at 10 per cent level of protein intake, but no significant differences were observed in the P.E.R of the proteins of the two foods at 15, 20 and 25 per cent levels of protein intake, at which such foods are normally used for infant feeding.

3. The average weekly growth of rats fed on the infant food composition (17.8 g) was slightly greater than that observed with milk food (15.8 g) but there was no significant difference in the feed efficiency ratios between the two foods.

4. There were no significant differences in the mean protein and fat contents of the livers or in the mean protein retained in the body of rats fed on the two foods.

Acknowledgment

The authors' thanks are due to Miss K. Indiramma and Mr N. Nataraja for help in the statistical analysis of the results.

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STUDIES ON THE PREPARATION AND SHELF LIFE OF SPRAY-DRIED PROTEIN FOOD BASED ON GROUNDNUT PROTEIN ISOLATE AND SKIM MILK POWDER SUITABLE FOR SUPPLEMENTING THE DIETS OF WEANED INFANTS

By V. Subrahmanyan, M. R. Chandrasekhara, Soma Korula*, N. Subramanian,
D. S. Bhatia, A. Sreenivasan and M. Swaminathan
(Central Food Technological Research Institute, Mysore)

Milk has been used from times immemorial as a supplement to the diets of weaned infants. Recent investigations have shown that skim milk powder together with a vitamin A supplement can also be used as an effective supplement to the diets of weaned infants[1]. It has the advantage of being less costly than whole milk powder. In many tropical and subtropical countries, the production of milk and other protective foods is highly inadequate to meet the needs of the population[2]. Consequently diseases due to the deficiency of protein and certain vitamins and minerals are widely prevalent especially among children in these countries[1]. Attempts are being made to use protein-rich foods of vegetable origin such as oilseeds, oilseed meals and legumes as supplements to the diets of weaned infants and for the treatment of protein malnutrition[3-5]. These foods, however, have the following defects as compared with skim milk powder:

(i) they can be used only in the form of porridge which is generally less acceptable to children than milk and

(ii) they contain insoluble carbohydrates which may cause digestive upsets in weaned infants.

In view of this, methods have been standardised by some workers for the preparation of readily dispersible dried milk substitutes based on soyabean and groundnut[6-8]. The present studies deal with the preparation and shelf life of a spray-dried protein food having a composition similar to that of skim milk powder and based on groundnut protein isolate and skim milk powder. The product is suitable for use as a supplement to the diets of weaned infants and for the treatment of protein malnutrition in children.

Experimental

Process. The process consisted of the following steps:

(i) peptisation of the wet protein in water by the addition of alkali and buffer salts

(ii) addition of dextri-maltose to reduce the protein content to 36% and homogenisation of the mixture

(iii) pasteurisation and spray drying

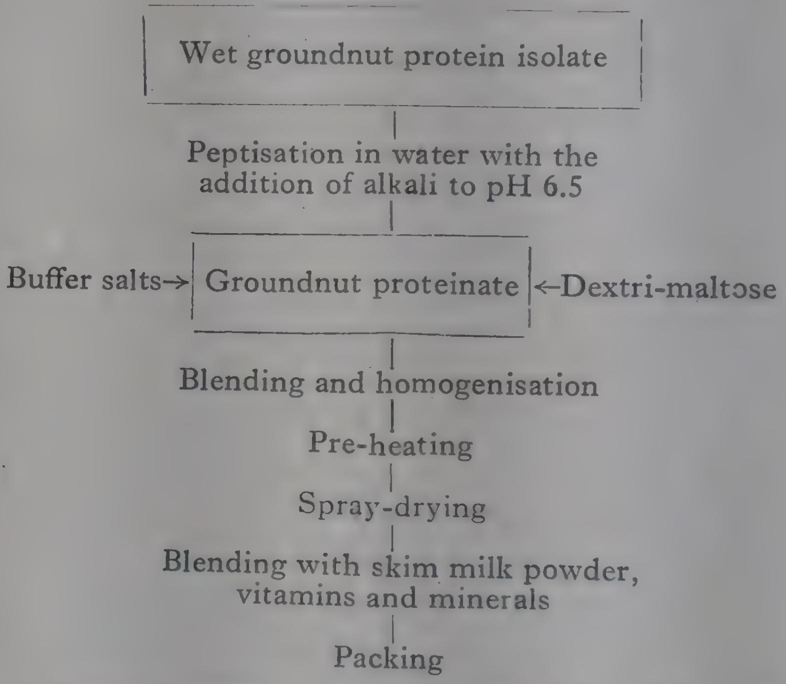
(iv) admixture with skim milk powder

(v) fortification with minerals and vitamins and

(vi) packing.

The details of the process were the same as that described by Subrahmanyan *et al.*,[9] for the preparation of infant food composition except that the fat was omitted. The flow sheet of the process is shown in Fig. 1.

FIG. 1. *Flow sheet of the process for the preparation of a spray-dried protein food*


Wet groundnut protein isolate
Peptisation in water with the addition of alkali to pH 6.5
Buffer salts→
Groundnut proteinate
←Dextri-maltose
Blending and homogenisation
Pre-heating
Spray-drying
Blending with skim milk powder, vitamins and minerals
Packing

Chemical composition and shelf life. The chemical composition of the food as determined by A.O.A.C. methods[10] is given in Table I. The standard plate count was made according to the methods of the American Public Health Association[11]. The solubility of the product was determined according to Howatt *et al*[12].

The product was packed in seamed tin cans (250 g.) under nitrogen, according to Chandrasekhara *et al*[9] and stored at three different temperatures *i.e.*, room temperature (25-29°C), 37°C and 45°C. Two cans from each lot were examined at monthly intervals for colour, solubility, peroxide value,

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* Unichem Research Fellow.

TABLE I. *Chemical composition*[1] *of spray-dried protein food based on groundnut protein isolate*
(values per 100g)

Moisture (g)	3.1	Thiamine (mg)	0.94
Protein (N × 6.25) (g)	35.2	Riboflavin (mg)	1.53
Fat (g)	1.8	Niacin (mg)	6.2
Ash (g)	6.2	Calcium pantothenate (mg)	4.0
Carbohydrate (g) (by diff)	53.7	Pyridoxine (mg)	0.6
Calcium (g)	1.42	Folic acid (mg)	0.1
Phosphorus (g)	0.98	Inositol (mg)	150
Vitamin A (I.U.)	1,500	Choline (mg)	150
Vitamin D (I.U.)	400	Biotin (μg)	3.5
Vitamin E (mg)	5.0	Vitamin B_{12} (μg)	3.0

[1] The added amounts of vitamins are given in the table except in the case of vitamin A, thiamine and niacin which were assayed.

vitamins A and C and organoleptic quality according to the methods used by Chandrasekhara *et al*[9].

Results and Discussion

The results (Table II) show that the spray-dried protein food has a good solubility and keeping quality. The losses of vitamin A and vitamin C in samples stored at 37°C for 7 months were about 34 per cent and 33 per cent respectively. The product after storage was acceptable to a panel of tasters.

TABLE II. *Effect of storage on the quality of spray-dried protein food based on groundnut protein isolate*

Storage temperature	...	RT (25-29°C)	37°C
Period of storage	Initial	7 months	7 months
Organoleptic quality	Acceptable	Acceptable	Acceptable
Colour of powder	Grey white	Grey white	Grey white
Solubility	88	87	86
Peroxide value[1]	0.3	0.5	0.6
T.B.A. value[2]	0.06	0.08	0.08
Vitamin A (I.U./100g)	1,500	1,060	980
,, C (mg/100g)	30	22	20

[1] Expressed as milliequivalents of oxygen per kg of powder.

[2] Expressed as optical densities.

The product had a low total plate count (14,600/g) and was free from *B. coli*, *Salmonella*, and anaerobic pathogens. The results of studies on the protein efficiency ratio, supplementary value of the product to poor rice diet and efficacy of the product in the treatment of protein malnutrition in children are reported in the subsequent papers of this series.

Summary

1. A spray-dried protein food containing about 36 per cent protein has been prepared by blending 2 parts of a spray-dried powder obtained from a mixture of groundnut protein isolate and dextrimaltose with 1 part of skim milk powder and fortifying with essential minerals and vitamins.

2. The product had a low total plate count and was free from *B. coli*, *Salmonella* and anaerobic pathogens. The product stored well at 37°C over a period of 7 months. The product reconstituted readily in warm water yielding a milk-like dispersion which was quite acceptable to a panel of tasters.

Acknowledgment

Authors are thankful to M/s Raptakos Brett and Co., Bombay for providing all facilities for the spray-drying of the product.

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NUTRITIVE VALUE OF SPRAY-DRIED PROTEIN FOOD BASED ON GROUNDNUT PROTEIN ISOLATE AND SKIM MILK POWDER

By Soma Korula*, M. R. Chandrasekhara, N. Nataraja, D. S. Bhatia, M. Swaminathan, A. Sreenivasan and V. Subrahmanyan

(Central Food Technological Research Institute, Mysore)

In a previous publication, the results of studies on the preparation and shelf life of a spray-dried protein food based on groundnut protein isolate and skim milk powder were reported[1]. The product had a composition similar to that of skim milk powder. Before testing the efficacy of the product in the treatment of protein malnutrition in children, it was considered desirable to assess the nutritive value of the product by conducting experiments on albino rats. The present paper deals with studies on the protein efficiency ratio of the proteins and the supplementary value of the protein food to poor rice diet, as compared with skim milk powder.

Experimental

Materials: The spray-dried protein food used in the investigation was the same as that described in an earlier paper[1]. For comparison, spray-dried skim milk powder was used. The chemical compositions of the skim milk powder and of spray-dried protein food were determined by A.O. A.C. methods[2]. The results are given in Table I.

The essential amino acid make-up as determined according to the methods of Krishnamurthy *et al.*[3] is given in Table II.

Protein efficiency ratio (*P.E.R*). The P.E.R of the proteins of the protein food as compared with skim milk powder was determined at three levels of protein intake (10, 15 and 20 per cent) by the growth method of Osborne, Mendel and Ferry[4]. The experiment was conducted in two series. Groups of male albino rats (weighing about 45 g. and distributed according to body weight and litter-mates) were used in the experiments. The composition of the experimental diets was similar to that described by Korula *et al*[5]. The protein food or skim milk powder was the sole source of proteins in the diets which

Table I. *Chemical composition of spray-dried protein food* based on groundnut protein isolate and of skim milk powder†* (values per 100 g)

Constituents		Spray-dried protein food	Skim milk powder
Moisture (g)	...	3.1	3.2
Protein‡ (g)	...	35.2	35.6
Fat (g)	...	1.8	1.1
Ash (g)	...	6.2	6.1
Carbohydrate (g) (by diff)	...	53.7	54.0
Calcium (g)	...	1.42	1.36
Phosphorus (g)	...	0.98	0.96
Vitamin A (I.U.)	...	1,500	1,500
Thiamine (mg)	...	0.94	0.54
Riboflavin (mg)	...	1.53	1.62
Niacin (mg)	...	6.2	6.1

* Spray-dried protein food was also fortified with vitamin D, 400 I.U.; vitamin E, 5.0 mg; calcium pantothenate, 4.0 mg; pyridoxine, 0.6 mg; folic acid, 0.1 mg; inositol, 150 mg; choline 150 mg; biotin 3.5 μg; vitamin B_{12}, 3.0 μg.

† Skim milk powder was fortified with vitamin A, 1,500 I.U.; vitamin D, 400 I.U.; niacin 5.0 mg. The other B-vitamins present in skim milk powder were not assayed.

‡ Calculated by multiplying total nitrogen content by 6.25 for spray-dried protein food and 6.38 for skim milk powder.

Table II. *Essential amino acid content of spray-dried protein food and skim milk powder* (amino acids g/16 g.N.)

Amino acids		Spray-dried protein food	Skim milk powder
Arginine	...	8.6	4.2
Cystine	...	1.4	0.8
Histidine	...	2.4	2.6
Isoleucine	...	4.7	6 6
Leucine	...	7.5	10.9
Lysine	...	5.2	8.0
Methionine	...	1.4	2.9
Methionine+cystine	...	2.8	3.7
Phenylalanine	...	5.2	5.6
Threonine	...	3.4	4.3
Tryptophane	...	1.2	1.4
Valine	...	5.5	6.9

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* Unichem Research Fellow.

TABLE III. *Protein efficiency ratio of the proteins of spray-dried protein food and skim milk powder*
(Period of experiment: 4 weeks)

Source of protein in the diet	No. of male rats per group	Level of protein (%)	Average initial body weight (g)	Average gain in body weight (g)	Average protein intake (g)	Average P.E.R	Critical difference at different levels		
							5 %	1 %	0.1 %
Series I									
Protein food	10	10	49.3	53.8	23.07	2.33 ±0.07	...	...	0.473
Skim milk powder	10	10	49.5	72.4	21.76	3.32 (9 d.f.)	...	...	...
Series II									
Protein food	8	15	43.10	109.9	47.05	2.33 ±0.059	0.17	...	...
Skim milk powder	8	15	42.9	101.4	40.75	2.49 (49 d.f.)*	...	...	...
Series III									
Protein food	8	20	42.7	110.0	62.42	1.76 ±0.059	0.17	...	...
Skim milk powder	8	20	42.9	84.9	46.16	1.84 (49 d.f.)*	...	...	...

* Data from an experiment which included 8 groups of 8 animals each.

were made adequate in other dietary essentials. Records of food intake and weekly increase in body weight were maintained for each animal. The experiment lasted for a period of 4 weeks. The results are presented in Table III.

Supplementary value of the protein food to poor rice diet. The supplementary value of the protein food to poor rice diet at 10 per cent level as compared with skim milk powder was determined by the rat growth method. The compositions of the experimental diets are shown in Table IV. Three groups of freshly weaned albino rats (6 males and 6 females in each group, weighing about 43 g. and equally distributed according to sex and body weight in a randomized block design) were used. The rats were housed individually in cages with raised wire-screen bottoms. Each group was fed on one of the experimental diets for a period of 8 weeks. Records of weekly increase in body weight and daily food intake were maintained. After feeding for a period of 8 weeks, the animals were sacrificed. The haemoglobin and R.B.C. count in the blood of the animals and the moisture, protein and fat contents of the livers and carcasses of male rats were determined according to the methods used by Shurpaleker *et al*[6].

TABLE IV. *Composition of experimental diets used for studies on the supplementary value of protein food*

Ingredients*	Diet I (g)	Diet II (g)	Diet III (g)
Rice, raw, milled ...	78.5	68.5	68.5
Spray-dried protein food ...	...	10	...
Skim milk powder ...	...	...	10

*The other ingredients common to the three diets are as follows: red gram dhal (*Cajanus cajan*) 5.0; non-leafy vegetables (potato and brinjal) 8.20; leafy vegetables 2.10; groundnut oil 5.0; skim milk powder 0.9; and common salt 0.3 g.

The results are given in Tables V and VI.

Results and Discussion

The results presented in Table I show that the chemical composition of the spray-dried protein food is similar to that of skim milk powder.

Table III shows that the P.E.R of the proteins of the protein food (2.33) was significantly less than that of the proteins of skim milk powder (3.32) at 10 per cent level of protein intake; but at 15 and 20 per cent levels, at which levels the food is likely to be used in the treatment of *kwashiorkor*, there were no significant differences in the P.E.R of the proteins of the protein food (2.33 and 1.76) and skim milk powder (2.49 and 1.84).

Table V shows that both the protein food and skim milk powder when incorporated at 10 per cent level in poor rice diet, brought about a highly significant increase in the growth rate and also in the haemoglobin content and R.B.C. count in the blood of rats. There were no significant differences in the response to the two supplements.

The results presented in Table VI show that the mean protein contents of livers and carcasses of rats receiving the protein food or skim milk powder were significantly higher than those of the livers and carcasses of rats fed on the control rice diet. The mean fat contents of the livers of the rats receiving the supplements were significantly less than that of animals fed on the rice diet.

The results of the present investigation are of considerable importance to several countries in Asia, Africa and Latin America, where there is an acute shortage of milk and other protective foods. Blending of spray-dried protein food based on groundnut protein with skim milk powder in the ratio of 2:1 will help to extend considerably the available supplies of skim milk powder. The results of studies on the value of

TABLE V. *Effect of supplementing poor rice diet with spray-dried protein food and skim milk powder on the growth, haemoglobin and red blood cell of rats*

Duration of experiment : 8 weeks

(Mean values for 6 male and 6 female rats in each group)

Diet	Protein content of diet (on moisture free basis)	Initial body weight (g)	Final body weight (g)	Weekly gain in weight (g)	Haemoglobin g/100 cc.	Red blood cells (10^6/c.mm)
A. Poor rice diet ...	8.31	43.2	76.3	4.15	14.79	6.83
B. Poor rice diet + protein food ...	11.5	43.4	132.3	11.10	16.04	7.91
C. Poor rice diet + skim milk powder	11.6	43.1	128.2	10.61	15.84	7.82
Standard error based on 20 degrees of freedom ...				±0.27	±0.23	±0.12
Critical difference at 5% level ...				0.79	0.67	0.36
,, 1% level ...				1.08	0.92	0.50
,, 0.1% level ...				1.46	1.24	0.67

TABLE VI. *Composition of livers and carcasses of the rats fed on a rice diet supplemented with protein food and skim milk powder*

(Duration of experiment: 8 weeks; mean values for 6 males in each group)

Diet	Initial body wt. (g)	Final body wt. (g)	Composition of liver			Composition of carcass		
			Moisture %	Protein %	Fat %	Moisture %	Protein %	Fat %
A. Poor rice diet ...	42.8	79.0	72.42	18.01	3.75	62.78	17.32	13.57
B. Poor rice diet + protein food ...	43.2	140.0	70.70	20.10	3.03	57.70	20.05	16.70
C. Poor rice diet + skim milk powder	42.7	139.3	71.28	19.57	3.19	57.97	19.48	16.20
Standard error based on 10 degrees of freedom ...			±0.13	±0.21	±0.10	±0.34	±0.24	±0.34
Critical difference at 5% level ...			0.41	0.66	0.31	1.07	0.75	1.06
,, 1% level ...			0.58	0.94	0.44	1.52	1.07	1.51
,, 0.1% level ...			0.83	1.37	0.64	2.20	1.55	2.18

the protein food in the treatment of protein malnutrition in children are reported in another paper of this series.

Summary

1. The nutritive value of a spray-dried protein food based on groundnut protein isolate and skim milk powder and containing about 36 per cent protein has been studied in experiments on albino rats.

2. The protein efficiency ratios of the proteins of the protein food at 15 and 20 per cent levels (at which levels the food is likely to be used in the treatment of *kwashiorkor*) were the same as those of skim milk powder but at 10 per cent level of protein intake, P.E.R of the protein food was significantly less than that of skim milk powder.

3. Supplementation of a poor Indian rice diet with spray-dried protein food or skim milk powder at 10 per cent level (at which level the food is likely to be used as a supplement to the diets of weaned infants) brought about a marked improvement (to the same extent) in the growth of albino rats. The mean protein contents of the livers and carcasses of rats receiving the supplements were significantly higher than those of rats fed on the control rice diet.

Acknowledgment

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USE OF BLENDS OF GROUNDNUT PROTEIN ISOLATE AND SKIM MILK POWDER IN THE TREATMENT OF PROTEIN MALNUTRITION IN CHILDREN

By V. Subrahmanyan, R. K. Bhagawan, T. R. Doraiswamy, M. R. Chandrasekhara, Kantha Joseph, N. Subramanian, D. S. Bhatia, A. Sreenivasan and M. Swaminathan

(Central Food Technological Research Institute, Mysore)

The protein foods which have been extensively used in the treatment of protein malnutrition in children are half-cream milk, skim milk powder and calcium caseinate[1,2]. In view of the shortage in the supply of the above, in countries where protein malnutrition is widely prevalent, investigations have been carried out by several workers on the use of protein rich foods of vegetable origin in the treatment of *kwashiorkor*[3]. Soyabean, sesame and cottonseed meals, and blends of Bengal gram (*Cicer arietinum*), groundnut, groundnut flour and skim milk powder have been found by some workers to be effective in the treatment of mild and moderately severe cases of *kwashiorkor*[3-6]. In view of the severe *anorexia* and impaired digestion commonly observed in cases of *kwashiorkor*, it is generally found difficult to administer large quantities of protein rich foods to provide 40-60 g. of protein. Oftentimes, tube feeding will have to be resorted to in the first week of treatment in severe cases[7]. In view of this, there is an urgent need for developing high protein foods which will readily disperse in warm water and which will be readily acceptable to the children. This can be achieved by the use of protein isolates obtained from oilseed meals which are 2-3 times as rich in proteins as the parent materials.

A preliminary account of the results of treatment of 8 cases of *kwashiorkor* with two blends has already been published[8]. Blend I consisted of groundnut protein (26 parts), soya bean protein (33 parts) and casein (41 parts) fortified with l-lysine-HCl and methionine and blend II was made up of groundnut protein (52 parts) and skim milk powder (48 parts). The present paper relates to studies on the treatment of *kwashiorkor* using (1) a protein food containing about 72 per cent protein and based on 2:1 blend of groundnut protein isolate and skim milk powder and (2) a spray-dried protein food containing about 35 per cent protein and based on groundnut protein isolate, dextri-maltose and skim milk powder.

Experimental

Materials. Groundnut protein used in the present study was prepared according to Anantharaman *et al*[9]. Two protein blends having the following compositions were used in this study.

(1) Protein blend III consisted of a mixture of two parts of groundnut protein isolate powder (60 mesh) and one part of skim milk powder.

(2) Spray-dried protein food was prepared according to Subrahmanyan *et al*[10] from a blend of groundnut protein, dextri-maltose and skim milk powder and was fortified with essential minerals and vitamins.

Buffer salts as indicated in the footnote of Table I were added to protein blend III for helping in

Table I. *Composition of protein blends based on groundnut protein and skim milk powder*

Ingredients	Protein blend[1] III (parts)	Spray-dried protein food[2] (parts)
Groundnut protein isolate ...	66.6	26
Skim milk powder ...	33.3	34
Dextri-maltose ...	...	34
Mineral salts[3] ...	7.5	6
Protein (N × 6.25) % ...	72.1	35.2

[1] Blend III consisted of a physical mixture of groundnut protein isolate, skim milk powder and the mineral salts.

[2] The process of preparation and the chemical composition of this blend have been described in an earlier paper of this series by Subrahmanyan *et al.*[7] The blend has been fortified with all essential vitamins.

[3] The following mineral salts were added to 100 g. of Blend III: di-potassium hydrogen phosphate 3.5 g; di-sodium hydrogen phosphate 2.0 g; potassium bicarbonate 1.0 g; tricalcium phosphate 0.5 g; calcium carbonate 0.5 g.

the reconstitution of the proteins in water. Calcium salts were also added to meet the daily requirement of calcium. The subjects receiving this blend were also given a vitamin supplement to meet the daily needs.

The compositions of the two blends are shown in Table I. The amino acid compositions of the two protein foods as compared with that of skim milk powder and FAO reference protein pattern are given in Table II.

TABLE II. *Essential amino acid composition of protein blends based on groundnut protein isolate and skim milk powder*
(amino acids g/16 g. N)

Amino acid	Protein blend III	Spray-dried protein food	Skim milk powder	FAO reference protein pattern
Arginine	9·2	8.6	4.2	...
Cystine	1·3	1.4	0.8	...
Histidine	2.4	2.4	2.6	...
Isoleucine	4·5	4·7	6.6	4.2
Leucine	6·7	7·5	10.9	4.8
Lysine	3.7	5.2	8.0	4.2
Methionine	1·2	1.4	2.9	2.2
Methionine + cystine	2·5	2.8	3.7	4.2
Phenylalanine	5·1	5.2	5.6	2.8
Threonine	3·0	3·4	4.3	2.8
Tryptophane	1.1	1.2	1.4	1.4
Valine	5.1	5.5	6.9	4.2

Reconstitution of protein blends : The quantity of protein blend III required for one dose (11 g.) was taken in a cup and made into a smooth paste with a small amount of warm water. To this, half a cup of boiling water and two teaspoons of cane sugar were added. The mixture was stirred well with a spoon for 2-3 minutes. The protein dispersed readily in water yielding a milk-like emulsion containing about ·6 per cent protein. The reconstituted product was readily consumed by the children.

Spray-dried protein food (22 g.) was taken in a cup. Sufficient cold water was added to form a smooth paste. Four ounces of boiling water and two teaspoons of cane sugar were then added. The mixture was stirred well. The resulting milk-like product containing about 5-6 per cent protein was readily consumed by the children.

The skim milk powder was reconstituted in the same way as the spray-dried protein food and fed to the children.

Clinical features and laboratory findings : All the cases were admitted to local hospitals for treatment. Immediately after admission, they were clinically examined and samples of blood, urine and stools were collected for examination. Ten cases of *kwashiorkor* (in the age group 1-5 years) were treated with the protein blend III, nine cases with spray-dried protein and ten cases with skim milk powder. The cases as and when admitted were assigned to one of the three groups so that each group contained cases of equal degrees of severity.

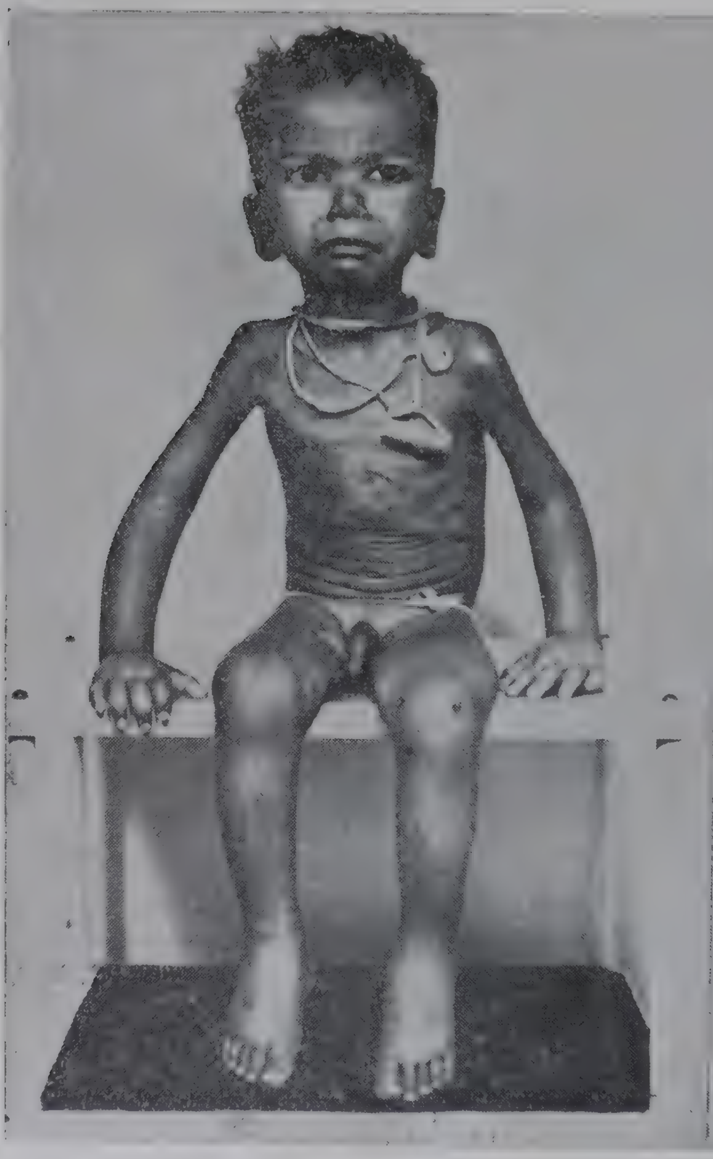
In all the subjects, generalised oedema was present. Fourteen cases showed mild angular stomatitis and fifteen cases showed skin changes *i.e.*, crazy pavement dermatosis over the legs. Twelve cases showed discoloration of hair. Liver and spleen were not palpable in any of the cases. Conjunctiva were pale and anaemic in all cases. The urine was normal except for traces of albumin. No parasitic ova, cysts or amoeba were found in the stools of 16 out of 29 cases. Round worm ova were found in the stools of 13 cases. The haemoglobin content was low (3.5—6.4 g/100 ml. blood) and red blood cell count varied between 2.5—3.5 million/cu.mm. Serological tests for syphilis were negative in all the cases. The initial total protein and albumin contents of serum were very low.

Treatment and results: The protein blends and skim milk powder were reconstituted in water as described above and were administered to the subjects four times[1] a day. The total quantity of protein administered from the protein blends was about 30 g per day. After a few days of treatment, additional calories were given in the form of bread, cooked rice and ripe plantain. The intake of protein was about 4-5 g./kg and of calories 100-110/kg. body weight. The subjects were weighed daily. Blood was drawn on the 10th and 30th day from the start of treatment, for the determination of serum proteins, haemoglobin and red blood cell count.

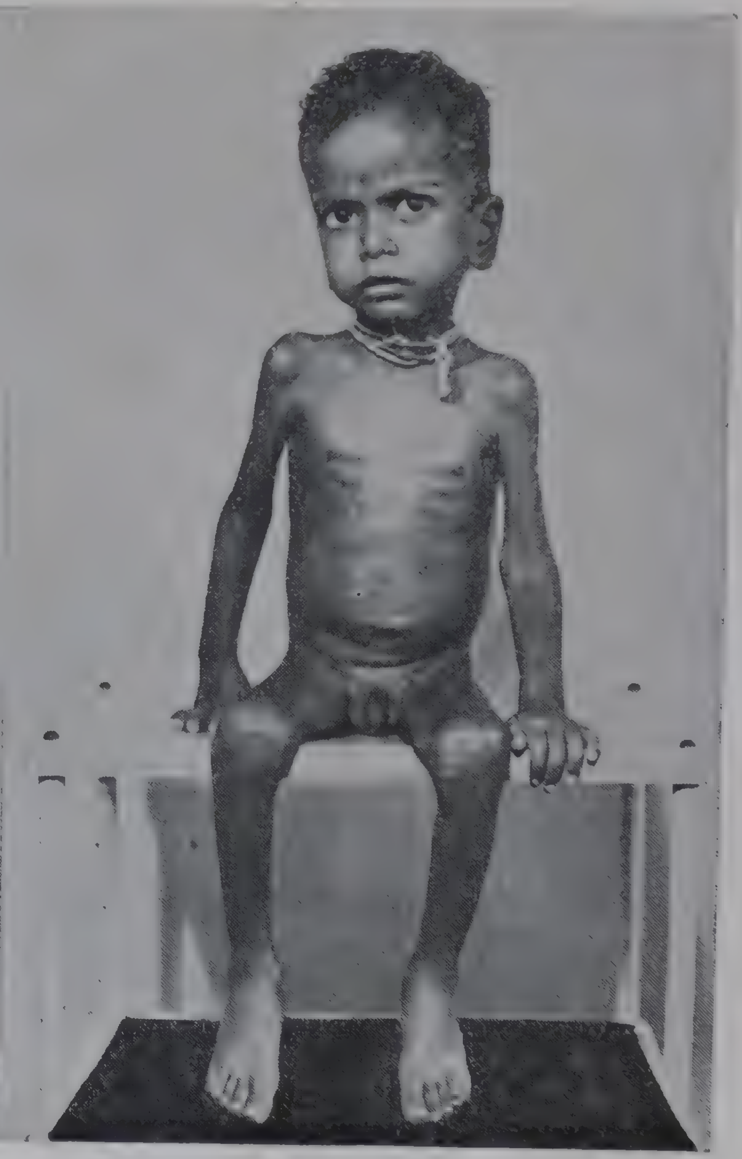
Results and Discussion

The oedema showed signs of decrease from the 3rd or 4th day and completely disappeared in about 14 days in a majority of the cases. The results summarized in Table III, reveal that the average time taken for the disappearance of oedema was 14.5 days with blend III, 11.7 days with spray-dried protein food and 12.1 days with skim milk powder. Diarrhoea began to subside within a week of the institution of protein therapy in a majority of cases. The average time taken for the stoppage of diarrhoea was 6.2 days with blend III, 8.9 days with spray-dried protein food and 10.5 days with skim milk powder. The dermatosis and hyper-pigmentation showed signs of healing from about the 10th day onwards and was completely healed by about the 30th day. The photographs of two cases of *kwashiorkor* treated with the protein blends are given in Fig. 1 and 2.

The results indicate that the two protein blends based on groundnut protein isolate and skim milk powder are almost as effective as skim milk powder alone in the treatment of *kwashiorkor* in children. The rate of regeneration of serum albumin with protein blend III was less than that found with the spray-dried protein food or skim milk powder. This may be due to the fact that blend III contained less amounts of lysine than the spray-dried protein food or skim milk powder. It is of interest to note that the spray-dried protein food based on groundnut



Child B, on admission showing severe generalised oedema and skin changes (mild pigmentation and ulceration on the legs).



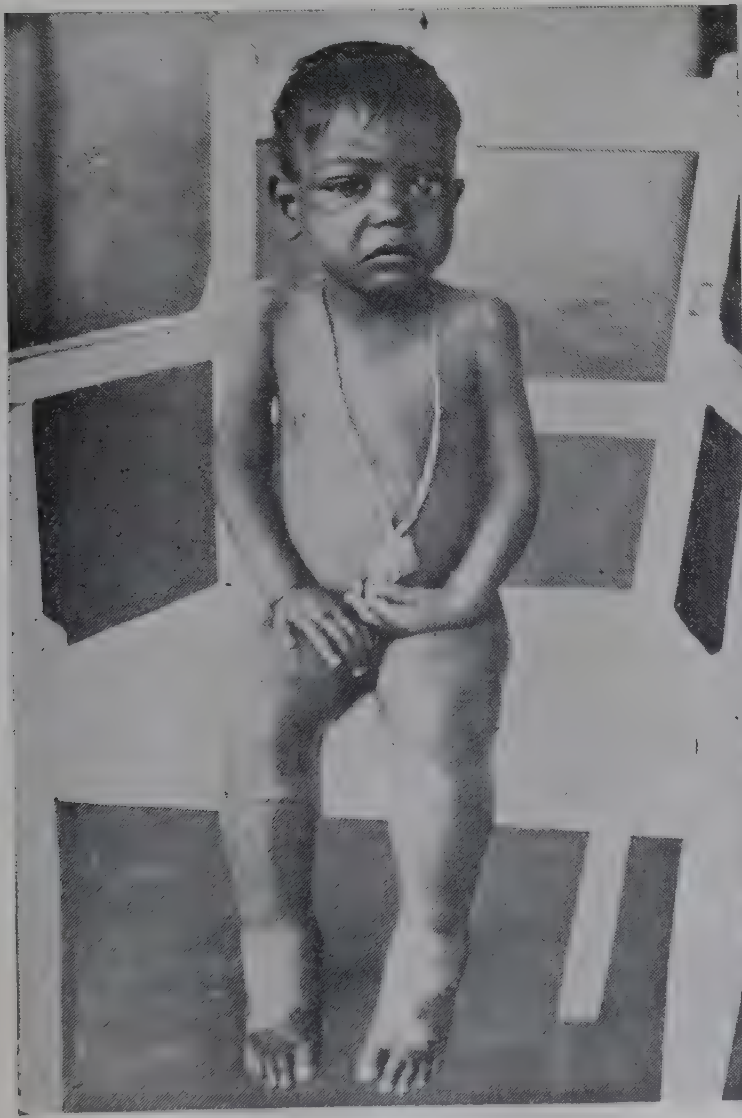
Same child B, showing the disappearance of oedema after 7 days' treatment with spray-dried protein food based on groundnut protein isolate.

protein and skim milk powder proved as effective as skim milk powder in the treatment of *kwashiorkor*. These results are in conformity with those of Dean[11] who found that administration of 30-40 g. protein in the form of biscuits containing 20 per cent protein (15 per cent from groundnut and 5 per cent from skim milk powder) was as effective as skim milk powder in the treatment of *kwashiorkor*. The biscuits used by Dean[11] suffered from the disadvantage of having a low protein content, thus necessitating the administration of 150-200 g. of biscuits daily to every child.

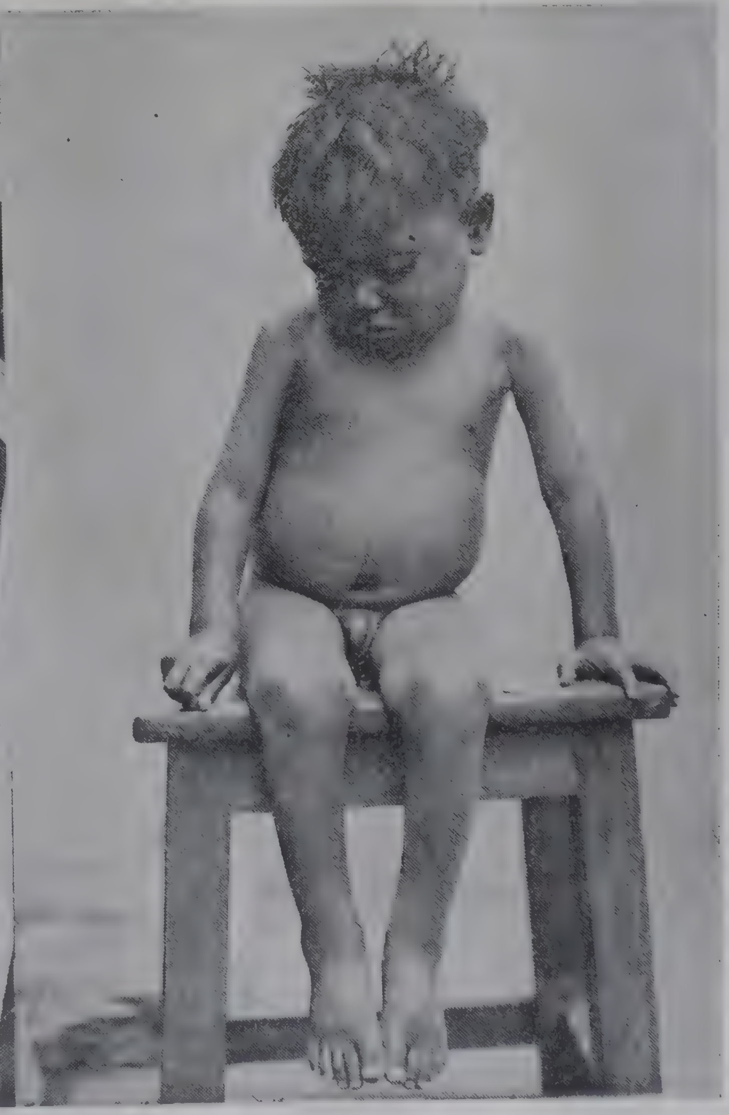
The results obtained in the present study have been independently confirmed by Dr Gopalan of Nutrition Research Laboratories, Hyderabad* (India) and also by Drs Webb and Dumm of the Christian Medical College and Hospital, Vellore*, (India). It may, therefore, be concluded that 2:1 or 1:1 blends of groundnut protein isolate and skim milk powder or a spray-dried protein food based on groundnut protein isolate, dextrimaltose and skim milk powder could be used with advantage in the treatment of protein malnutrition. The use of such blends will help to extend the available supplies of skim milk powder. There is considerable scope for the production and use of such protein blends in the treatment of *kwashiorkor* in several tropical and sub-tropical countries.

Summary

1. Nineteen cases of *kwashiorkor* aged 1-5 years were treated with two protein blends (1) *protein blend III*, consisting of a mixture of



Child C, on admission showing severe generalised oedema and skin changes (excoriation and hyperpigmented areas).



Same child C, completely cured after treatment with protein blend III for 25 days.

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* Private communications.

TABLE III. *Changes in body weight and serum albumin and time taken for the disappearance of oedema in cases of kwashiorkor treated with protein blends based on groundnut protein isolate and skim milk powder*

		Protein blend III	Spray-dried protein food	Skim milk powder
No. of cases treated		10	9	10
Age in years ...		1—5	2—5	3—5
Body weight (kg) ...	Range Mean	5.9—11.5 8.2	7.8—11.2 9.8	7.6—11.3 9.85
Protein administered g/child/ day from protein food ...		30	30	30
from cereals ...		8—10	8—10	8—10
No. of days taken for clinical disappearance of oedema:	Range Mean	7—18 14.5	9—17 11.7	9—19 12.1
No. of days taken for disappearance of diarrhoea	Range Mean	5—12 6.2	5—12 8.9	4—15 10·5
No. of days taken for attaining minimum body weight	Range Mean	8—19 14·6	6—13 8·4	9—18 10.1
No. of days taken for an increase of one pound body weight calculated from 1st day of reaching minimum wt.	Range Mean	6—15 10.0	6—10 7.9	5—11 7.3
Rise of serum albumin on 10th day	Range Mean	0.5—1.2 0.75	0.7—1.4 0.97	0.8—1.5 1.0
Rise of serum albumin on 30th day	Range Mean	1.0—2.1 1.40	1.6—2.7 2.09	1.7—3.0 2.20

2 parts of groundnut protein isolate and 1 part of skim milk powder and (2) *a spray-dried protein food* containing about 35 per cent protein and based on groundnut protein isolate, dextri-maltose and skim milk powder. For comparison, ten cases were treated with skim milk powder also.

2. Each child in the different groups received 30 g. of protein daily. The reconstituted protein blends were readily consumed and digested by the children. Diarrhoea stopped in a shorter time in children receiving the protein blends as compared with those receiving skim milk powder.

3. The two blends compared favourably with skim milk powder in their effectiveness in the treatment of *kwashiorkor*. The rate of regeneration of serum albumin in children treated with spray-dried protein food and skim milk powder was greater than that observed in children treated with protein blend III.

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NUTRITIVE VALUE OF A HIGH PROTEIN BISCUIT-LIKE PRODUCT CONTAINING GROUNDNUT PROTEIN ISOLATE AND CASEIN AND FORTIFIED WITH CALCIUM SALTS AND VITAMINS

By M. R. Chandrasekhara, Soma Korula*, K. Indiramma, D. S. Bhatia,
M. Swaminathan, A. Sreenivasan and V. Subrahmanyan
(Central Food Technological Research Institute, Mysore)

Biscuit is a popular item in the diet of weaned infants and young children. Biscuits of commerce, in general, have a low protein content[1]. Studies on the preparation and nutritive value of Nutro biscuit based on wheat flour and groundnut flour and containing about 17 per cent protein have been reported by Subrahmanyan *et al*[2]. Dean reported that a biscuit based on groundnut, wheat flour and skim milk powder containing about 20 per cent protein was quite effective in the treatment of protein malnutrition in children[3]. In the present paper, the results of studies on the preparation and nutritive value of a biscuit-like product based on groundnut protein isolate and casein and containing about 51 per cent protein are reported.

Experimental

Materials: Groundnut protein isolate used in the present study was prepared according to the method of Anantharaman *et al*[4]. The wet protein was peptised in water by the addition of alkali and the pH of the dispersion was adjusted to 6.5—6.6 by the addition of potassium-dihydrogen phosphate. It was then dried on a twin roller drier at 50 lb steam pressure. Both the protein isolate and casein were powdered to pass through a 60 mesh sieve.

Preparation of biscuit-like product: The different ingredients (Table I) were mixed thoroughly in a mechanical mixer. Sufficient quantity of water was sprayed on the blend so as to raise the moisture content to about 15 per cent. The blend was pressed in a manually operated press having circular dies of 5 cm. diameter. The biscuit-like product thus obtained (5 cm. diameter and 0.5 cm. thickness) was baked in a thermostatically controlled baking oven at 380°F for 5 minutes.

Table I. *Composition of the biscuit mix*

Ingredients	Parts
Groundnut protein isolate (roller dried)	48
Casein	12
Cane sugar	22
Vanaspati[1] (hydrogenated groundnut oil containing 5% sesame oil)	10
Cocoa	2
Salt mixture[2]	4
Vitaminised starch[3]	1
Baking powder	1

[1] Vitamin A (6000 I.U.) and vitamin D (400 I.U.) were added to 10g vanaspati.

[2] Salt mixture consisted of the following salts: tricalcium phosphate 2 parts, calcium carbonate 1 part, potassium dihydrogen phosphate 0.5 part, disodium phasphate 0.5 part.

[3] Vitaminised starch contained per gram the following quantities of different vitamins: thiamine 1.5 mg; riboflavin 1.5 mg; niacin 6.0 mg; pyridoxine 1.0 mg; calcium pantothenate 3.0 mg; folic acid 0.2 mg; inositol 150 mg; choline 150 mg and vitamin B_{12}, 3.0 μg.

Analytical: The chemical composition of the biscuits was determined by A.O.A.C. methods[5]. The losses of vitamins during baking were also determined. The product was packed in polythene bags (2 biscuits in each bag) and two of them were placed in a tin can (250 g.) and sealed. The cans were stored at room temperature (25°-29°C) and 37°C. One can from each lot was examined at two-monthly intervals for colour, peroxide value, T.B.A. value and organoleptic quality according to the methods used by Chandrasekhara *et al*[6]. Vitamin A, thiamine, riboflavin and niacin were determined according to A.O.A.C. methods[5].

The results are given in Tables II and III.

The organoleptic evaluation of the fresh and stored product was carried out by a panel of tasters selected from the Institute staff.

The essential amino acid composition of the

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* Unichem Research Fellow.

TABLE II. *Chemical composition of the high protein biscuits*

Moisture (g)	2.8	Thiamine (mg.)	1.33
Protein (g)	51.6	Riboflavin (mg.)	1.42
Fat (g)	10.1	Niacin (mg.)	5.8
Minerals (g)	6.2	Ca. pantothenate (mg.)	3.0
Carbohydrates (g) (by diff)	29.3	Pyridoxine (mg.)	0.6
Calcium (g)	1.26	Folic acid (mg)*	0.1
Phosphorus (g)	1.12	Inositol (mg.)*	150
Vitamin A (I.U.)	5360	Choline (mg.)*	130
,, D (I.U.)*	400	Vitamin B_{12} (μg.)*	2.2

* Added amounts of vitamins shown.

TABLE III. *Effect of storage on the quality of high protein biscuits*

	Initial	Storage period 6 months	 6 months
Storage temperature	...	R.T.	37°C
Organoleptic evaluation	Acceptable	Acceptable	Acceptable
Colour	Greyish yellow	Greyish yellow 1.0	Greyish yellow 1.5
Peroxide value[1]	nil	0.5	0.8
T.B.A. value[2]	0.03	0.06	0.08
Vitamin A (I.U.)	5,360	4,240	3,490
Vitamin B_1 (mg.)	1.33	1.25	1.14

[1] Expressed as millimols of oxygen per kg. of fat in powder.

[2] Expressed as optical densities.

proteins of the biscuit and the sample of skim milk powder used in the study were determined according to the methods used by Krishnamurthy *et al*[7]. The results together with the amino acid pattern of FAO reference protein are given in Table IV.

Animal experiments: The protein efficiency ratio of the proteins of the biscuit as compared with that of unbaked biscuit mix and casein was determined by the growth method of Osborne, Mendel and Ferry[8]. The compositions of the experimental diets are given in Table V. Freshly weaned albino male rats weighing about 47 g. were allotted to three groups (6 rats per group) according to body weight in a randomized block design. The rats were housed individually in cages with raised wire-screen bottoms. Each group was fed on one of the experimental diets for a period of 4 weeks. Records of the food intake and increase in body weight of each animal were maintained. The protein efficiency ratios obtained are presented in Table VI.

TABLE IV. *Essential amino acid composition of the high protein biscuit as compared with skim milk powder and reference protein pattern.* (amino acids g/16 g N)

	High protein biscuit	Skim milk powder	F.A.O. reference protein pattern[1]
Arginine	9.17	4.26	...
Cystine	1.26	0.93	...
Histidine	2.37	2.38	...
Isoleucine	4.42	7.28	4.2
Leucine	6.76	10.85	4.8
Lysine	4.35	8.27	4.2
Methionine	1.28	2.86	2.2
Methionine + cystine	2.54	3.79	4.2
Phenylalanine	4.86	5.48	2.8
Threonine	2.92	4.63	2.8
Tryptophane	1.12	1.42	1.4
Valine	5.26	6.54	4.2

[1] *Protein requirements*—Report of the F.A.O. Committee, Food and Agriculture Organisation Rome, 1957.

TABLE V. *Composition of the Experimental diets used for determination of P.E.R.*

Ingredients	Diet I (Biscuits)	Diet II (Unbaked mix)	Diet III (Casein)
Biscuit powder	19.0	...	...
Biscuit mix	...	19.0	...
Casein	...	...	11.0
Groundnut oil	7.8	7.8	9.5
Shark liver oil	0.5	0 5	0.5
Salt mixture*	2.0	2 0	2.0
Vitaminised starch†	1.0	1.0	1.0
Sugar	10.0	10.0	10.0
Corn starch	59.7	59.7	66.0

* McCollum and Davis salt mixture.

† Shurpaleker, *et al. Annal. Biochem. and exptl. Med.* 1959, **19**, 269.

The supplementary value of the biscuit-like product to poor rice diet at 10 per cent level as compared with skim milk powder was determined by the rat growth method. The compositions of the experimental diets are shown in Table VII.

Three groups of freshly weaned albino rats (6 males and 6 females in each group weighing about 45 g. and equally distributed according to sex and body weight in a randomized block design) were used. After feeding for a period

TABLE VI. *Comparative protein efficiency ratio of the proteins of high protein biscuits, unbaked biscuit mix and casein*

(Level of protein in diet 10%; 6 male rats in each group)
Period of experiment: 4 weeks

Group	Diet	Average initial weight (g)	Average increase in weight (g)	Average protein intake (g)	Average P.E.R.	
A.	High protein biscuits ...	48.3	33.8	17.22	1.97	±0.108 (10 d.f.)
B.	Unbaked biscuit mix	48.3	43.3	19.14	2.26	
C	Casein ...	48.5	56.3	22.09	2.55	

Critical difference at ... 5% level 0.341
1% level 0.485

of 8 weeks, the haemoglobin and R.B.C. count of the blood were determined according to the methods used by Shurpaleker *et al*[9]. The animals were sacrificed and the livers and carcasses were analysed for moisture, protein and fat according to the methods used by Shurpaleker *et al*[9]. (Tables VIII and IX).

TABLE VII. *Composition of experimental diets* used for studies on supplementary values*

	Diet I (g)	Diet II (g)	Diet III (g)
Rice, raw, milled ...	78.5	68.5	68.5
High protein biscuit ...	...	10.0	...
Skim milk powder ...	...	...	10.0

The other ingredients common to the three diets were as follows:

Red gram dhal (*Cajanus cajan*) 5.0; non-leafy vegetables (potato and brinjal) 8.20; leafy vegetables 2.10; groundnut oil 5.0; skim milk powder 0.9 and common salt 0.3g.

Results and Discussion

The losses of vitamin A and thiamin, as a result of baking, were 11 and 11.3 per cent respectively. There was no appreciable loss of riboflavin or niacin acid. Narayanan *et al.*[10] reported a loss of 12-17 per cent of vitamin A in Nutro biscuits as a result of baking. Pyridoxine, calcium pantothenate, folic acid and vitamin B$_{12}$ contents were not assayed.

There was some increase in the peroxide value and T.B.A. values of the fat in the stored samples,

TABLE VIII. *Effect of supplementing poor rice diets with high protein biscuits and skim milk powder on growth, haemoglobin and red blood cell count of albino rats*
Duration of experiment: 8 weeks
(Mean values for 6 males and 6 females in each group)

Diet	Protein content of diet on moisture free basis (%)	Average initial body weight (g)	Average weekly gain in body weight (g)		Haemoglobin g/100 ml.		Red blood cells 10^6/c.mm	
A. Poor rice diet ...	8.31	46.6	4.34	±0.23 (20 d.f.)	15.21	±0.16 (20 d.f.)	6.86	±0.12 (20 d.f.)
B. Poor rice diet + high protein biscuits ...	12.9	46.5	11.75		16.10		7.58	
C. Poor rice diet + skim milk powder ...	11.4	46.6	11.24		16.00		7.35	
Critical difference at 5% level			0.68		0.46		0.34	
1% ,,			0.93		0.62		0.46	
0.1% ,,			1.26		0.84		0.63	

TABLE IX. *Composition of liver and carcass of rats fed on a rice diet supplemented with high protein biscuits*
(Duration of experiment: 8 weeks; mean values of 6 males in each group)

Group no.	Diet	Average initial body weight (g)	Average final body weight (g)	Composition of liver			Composition of carcass		
				Moisture %	Protein %	Fat %	Moisture %	Protein %	Fat %
A.	Poor rice diet	45.7	83.8	72.45	18.17	3.79	62.61	18.07	13.87
B.	Poor rice diet + high protein biscuit	45.7	148.3	70·93	20.15	3.30	58.12	19.60	16.65
C.	Poor rice diet + skim milk powder	45.5	145.6	70.88	20.24	3.18	58.04	19.45	16.84
	Standard error with 10 degrees of freedom			± 0.26	± 0.15	± 0.14	± 0.17	± 0.23	± 0.18
	Critical difference at 5% level			0.82	0.48	0.43	0.55	0.73	0.58

(Table III). Organoleptic evaluation did not reveal any rancidity in the stored products. The losses of vitamin A and thiamine in samples stored at 37°C for 6 months were 37 per cent and 14 per cent respectively. These results are in conformity with those reported by Bhatia *et al.*[11].

The results given in Table VI show that the P.E.R. of the proteins of the biscuit (1.97) was slightly less than that of the unbaked biscuit mix (2.26), the difference being not statistically significant. The P.E.R. of the proteins of the biscuits was significantly less than that of casein (2.55) at 10 per cent level of protein intake.

Table VIII shows that supplementation of the rice diet with high protein biscuit or skim milk powder at 10 per cent level brought about a highly significant increase in the growth of rats. There was no significant difference, however, in the average weekly growth rate of rats receiving biscuit or skim milk powder. The data further show that supplementation of the rice diet with biscuit or skim milk powder produced a significant increase in the haemoglobin and R.B.C. count also. The mean protein contents of the livers and carcass of rats fed on the rice diets supplemented with biscuit or skim milk powder were significantly higher than those of the livers and carcass of rats fed on the control rice diet. The mean fat content of the livers of rats fed on the rice diet was higher than those of the livers of rats receiving supplements of biscuit or skim milk powder.

Further studies on the supplementary value of the high protein biscuits to the diets of weaned infants and in the treatment of protein malnutrition in children are being planned.

Summary

1. A biscuit-like product containing about 51 per cent protein has been prepared from a 4:1 blend of groundnut protein isolate and casein. The biscuit has been fortified with essential minerals and vitamins.

2. The losses of vitamin A and thiamine as a result of baking were 11.0 and 11.3 per cent respectively. There were no appreciable losses of riboflavin and niacin during baking. The losses of vitamin A and thiamine in high protein biscuits after storage for 6 months at 37°C were 35 per cent and 14 per cent respectively.

3. There were no significant differences in the P.E.R. of the proteins (at 10 per cent level) of the biscuit (1.97) or the unbaked biscuit blend (2.26). The P.E.R. of the proteins of the biscuit (1.97) was, however, significantly less than that of casein (2.55).

4. Supplementation of a poor rice diet with high protein biscuit or skim milk powder at 10 per cent level brought about a marked improvement in the nutritive value of the diet as judged by growth of rats. The mean protein contents of the livers and carcasses of rats fed on diets

supplemented with the biscuit or skim milk powder were significantly higher than those observed with rats fed on the control rice diet.

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EFFECT OF SUPPLEMENTING A POOR RICE DIET WITH GROUNDNUT PROTEIN ISOLATE FORTIFIED WITH CALCIUM SALTS AND VITAMINS ON THE METABOLISM OF NITROGEN, CALCIUM AND PHOSPHORUS IN CHILDREN

By KANTHA JOSEPH, P. K. TASKER, M. NARAYANA RAO, A. N. SANKARAN,
M. SWAMINATHAN, A. SREENIVASAN AND V. SUBRAHMANYAN

(*Central Food Technological Research Institute, Mysore*)

Recently, processes for the preparation of edible groundnut protein isolate from groundnut or low fat groundnut meal have been developed in this Institute[1, 2]. In earlier papers of this series, the results of investigations on the preparation and nutritive value of spray-dried infant food and protein food based on groundnut protein isolate and skim milk powder suitable for feeding infants and weaned children were reported[3-7]. The present paper deals with studies on the effect of supplementing a poor rice diet with groundnut protein isolate fortified with calcium salts and essential vitamins as compared with fortified groundnut flour or skim milk powder, on the metabolism of nitrogen, calcium and phosphorus in children.

Experimental

Materials: Groundnut flour used in this study was prepared from good quality groundnut kernels according to Subrahmanyan *et al*[8]. Groundnut protein isolate was prepared from groundnut meal according to Anantharaman *et al.*[2] A sample of skim milk powder of good quality was used. Groundnut protein isolate and groundnut flour were fortified with calcium carbonate and phosphate and vitamins so that the two protein foods provided nearly the same amounts of calcium, phosphorus and vitamins as skim milk powder when they were incorporated in amounts to provide 20 g. of protein. The protein foods and skim milk powder were fortified with vitamins A and D. The nutritive values of the protein foods and skim milk powder as determined by A.O.A.C. methods[9] are given in Table I.

Metabolism study: The plan of the metabolic study and analytical methods used were similar to those of Joseph *et al*[10]. The ages, heights and weights of the experimental subjects (girls) are given in Table II. The girls belonged to the low-income groups of the population and were residents of a local boarding home in Mysore

TABLE I. *Mean nutrient content of the protein rich supplements given daily to each child*

Nutrient	Groundnut flour[1]	Groundnut protein isolate[2]	Skim milk powder[3]
Protein (N × 6.25) (g.)	20.0	19.9	20.1
Calcium (mg.) ...	740	761	748
Phosphorus (mg.) ...	568	562	549
Vitamin A (I.U.)† ...	1,500	1,500	1,500
,, D (I.U.)† ...	150	150	150
Thiamine (mg.) ...	0.33	0.34	0.32
Riboflavin (mg.) ...	0.74	0.72	0.75
Niacin (mg.) ...	7.8	7.6	7.7
Ca. pantothenate (mg.)†	2.0	2.0	2.0
Pyridoxine (mg)† ...	0.6	0.6	0.6
Vitamin B_{12} (μg.)† ...	2.0	2.0	2.0

[1] Groundnut flour (40 g) fortified with Ca salts and certain vitamins.

[2] Groundnut protein isolate (22.5 g) fortified with Ca salts and certain vitamins.

[3] Skim milk powder (55.5 g) fortified with certain vitamins.

† Added values only.

TABLE II. *Ages, heights and weights of the children at the beginning of the experiment*

Child no.	Age (years)	Height (cm.)	Weight (kg.)
1	8	108	17.1
2	9	113	16.4
3	8	106	16.6
4	9	111	16.1
5	9	120	20.9
6	8	109	16.9
7	9	117	18.5
8	8	110	17.2

TABLE III. *Mean daily intake of foodstuffs by the children on the different diets**

Supplementary foods	Period I	Period II	Period III	Period IV
Corn starch (g.) ...	25.5	...	13.0	...
Sugar (g.) ...	30.0	15.5	20.0	...
Groundnut flour (fortified with calcium salts and vitamins) (g.) ...	...	40.0	...	...
Groundnut protein isolate (fortified with calcium salts and vitamins) (g.) ...	...	...	22.5	...
Skim-milk powder (fortified with vitamins A & D) (g)...	...	...	...	55.5

* Foodstuffs common to all the diets included:

Rice raw, milled 280 g; red gram dhal (*Cajanus cajan*) 20 g; groundnut oil 4 g; potato 20 g; brinjal (*Solanum melongena*) 20 g; amaranthus leaves (*Amaranthus gangeticus*) 10 g; tamarind pulp (*Tamarindus indicus*) 6.2 g; skim milk powder 5 g; common salt 11.2 g; onions 13 g; condiments (garlic, coriander seeds, mustard, red chillies and turmeric etc) 10.1 g.

City. The mean daily intakes of foodstuffs by the children from the different diets are given in Table III. The diets were designated as follows: (1) Rice diet (2) Rice-groundnut flour diet (Rice-GNF diet) (3) Rice-groundnut protein isolate diet (Rice-GPI diet) and (4) Rice-skim milk powder diet (Rice-SMP diet) respectively. The procedures adopted for the feeding and for the collection and preservation of excreta were similar to those of Joseph *et al*[10]. The protein foods were given in three divided doses along with breakfast, lunch and dinner. Total N, Ca and P in the diet, urine and faeces were determined by the methods of Murthy *et al*[11].

Results

Nitrogen metabolism: The results of N metabolism on the different diets are given in Table IV. The mean daily intakes of nitrogen on the Rice diet, Rice-GNF diet, Rice-GPI diet and Rice-SMP diets were 4.08, 7.30, 7.20 and 7.35 g. respectively. The 'apparent' digestibility coefficients of the protein in the different diets were, Rice diet, 72.0; Rice-GNF diet, 72.7; Rice-GPI diet, 76.6; Rice-SMP diet 76.0. The mean daily N retentions on the different diets were 0.75, 1.44, 1.67 and 2.22 g. respectively, the N balance on the diets supplemented with the protein foods being significantly higher ($P<0.001$) than that observed on the rice diet. All the subjects were in positive N balance.

Calcium metabolism: The results of Ca metabolism are given in Table V. All the subjects were in positive balance on the different diets. The mean daily intakes of Ca on the Rice diet,

TABLE IV. *Mean daily intake, excretion and balance of* **nitrogen** *by the children fed on the different diets*
Acclimatization and experimental period = 5 days each

Diet	Calories intake	Intake (g)	Excretion (g)			Apparent digestibility %	Balance (g)
			Urinary	Faecal	Total		
Rice ...	1394	4.08	2.19	1.14	3.33	72.0	+0.75
Rice+fortified groundnut flour ...	1382	7.30	3.86	1.99	5.85	72.7	+1.44
Rice+fortified groundnut protein ...	1388	7.20	3.85	1.68	5.53	76.6	+1.67
Rice+skim milk powder ...	1372	7.35	3.37	1.76	5.13	76.0	+2.22

Standard error of the mean (21 d.f.)	±1.73	±0.20
Critical difference at 5% level	5.09	0.59
1% level	—	0.80
0% level	—	1.08

TABLE V. *Mean daily intake, excretion and balance of* **calcium** *by the children fed on the different diets*
Acclimatization and experimental period = 5 days each

Diet	Calorie intake	Intake (mg)	Excretion (mg)			Balance (mg)
			Urinary	Faecal	Total	
Rice ...	1,394	262	49	169	218	+ 44
Rice + fortified groundnut flour ...	1,382	986	72	610	682	+ 304
Rice + fortified groundnut protein isolate ...	1,388	1,012	72	585	657	+ 355
Rice + skim milk powder ...	1,372	998	71	602	673	+ 325

Standard error of the mean (21 d.f.)	± 36.1
Critical difference at 5% level	106
1% ,,	144
0.1% ,,	195

Rice-GNF diet, Rice-GPI diet and Rice-SMP diets were 262, 986, 1012 and 998 mg. respectively. The mean daily retentions of Ca on the different diets were: Rice diet, 44 mg., Rice-GNF diet, 304 mg; Rice-GPI diet 355 mg. and Rice-SMP diet, 325 mg; the Ca balance on the supplemented diets being significantly higher ($P<0.001$) than that on the rice diet. No significant differences, however, were observed in the Ca balances on the diets supplemented with groundnut protein isolate, groundnut flour or skim milk powder.

Phosphorus metabolism: The results of phosphorus metabolism are given in Table VI. The mean daily intakes of P on the Rice diet, Rice-GNF diet, Rice-GPI diet and Rice-SMP diet were 535, 1037, 1031 and 1003 mg. respectively. The mean daily retentions of P on the different diets were 88, 436, 449 and 403 mg. respectively. No significant difference was observed in the P retentions on diets supplemented with the different protein foods. All the subjects were in positive P balance.

Discussion

The mean daily intakes of N, Ca and P by the children on the rice diet fell short of the recommended allowances of the Indian Council of Medical Research, Nutrition Advisory

TABLE VI. *Mean daily intake, excretion and balance of* **phosphorus** *by the children fed on the different diets*
Acclimatization and experimental period = 5 days each

Diet	Calorie intake	Intake (mg)	Excretion (mg)			Balance (mg)
			Urinary	Faecal	Total	
Rice ...	1,394	535	124	323	447	+ 88
Rice + fortified groundnut flour ...	1,382	1,037	115	486	601	+ 436
Rice + fortified groundnut protein isolate ...	1,388	1,031	105	477	582	+ 449
Rice + skim milk powder ...	1,372	1,003	100	500	600	+ 403

Standard error of the mean (21 d.f.)	± 22.4
Critical difference at 5% level	66.0
1% ,,	90.4
0.1% ,,	121

Committee[12]. Supplementation of the diet with groundnut protein isolate or groundnut flour fortified with Ca salts and vitamins or skim milk powder so as to provide daily 20 g. extra protein and substantial amounts of Ca and P made up the deficiencies and brought about a significant increase in the retention of N, Ca and P. These results are in conformity with those reported earlier with Indian multipurpose food by Joseph *et al*[13]. The apparent digestibility co-efficient of the proteins of the diet containing supplements of groundnut protein isolate was higher than that of the diet containing groundnut flour. This may be due to the fact the isolate was free from fibre and other unavailable carbohydrates present in the flour. The mean retention of nitrogen on diets supplemented with groundnut flour and groundnut protein isolate were, however, significantly less than those observed with the diets supplemented with skim milk powder. This may be due to the fact that the proteins of groundnut contribute less amounts of lysine and methionine than skim milk powder. There was no significant difference in the mean nitrogen retention on diets supplemented with groundnut protein isolate or groundnut flour. The added Ca and P in the form of calcium carbonate and phosphate to the protein foods were utilised almost to the same extent as the Ca and P of skim milk powder. There were no significant differences in the retention of Ca and P in the children receiving the different protein foods.

The results obtained in this investigation show that groundnut protein isolate or groundnut flour fortified with essential vitamins and minerals could be used for overcoming the deficiencies of proteins and other nutrients in the diets of children in regions where milk is not available in adequate amounts.

Summary

1. The effect on nitrogen, calcium and phosphorus metabolism of supplementing a poor rice diet with fortified groundnut flour or groundnut protein isolate or skim milk powder so as to provide extra amounts of protein (20 g.), calcium (740-761 mg.) and phosphorus (549-568 mg.) was studied in eight girls aged 8-9 years.
2. The mean daily intakes of nitrogen on the Rice diet, Rice-GNF diet, Rice-GPI diet and Rice-SMP diet were 4.08, 7.30, 7.20 and 7.35 g. respectively and the mean N retentions were 0.75, 1.44, 1.67 and 2.22 g. respectively. The apparent digestibility co-efficients of the proteins of the different diets were 72.0, 72.7, 76.6 and 76.0 respectively. All the experimental subjects maintained a positive N balance.
3. The mean daily calcium intakes on the different diets were 262.0, 986.0, 1012.0 and 998.0 mg. and the retentions were 44.0, 304.0, 355.0 and 325.0 mg. respectively on the rice diet and the same supplemented with groundnut flour, groundnut protein isolate and skim milk powder.

4. The mean daily phosphorus intakes were 535, 1037, 1031 and 1003 mg. and the retentions were 88, 436, 449 and 403 mg. respectively on the rice diet and the same supplemented with groundnut flour, groundnut protein isolate and skim milk powder.

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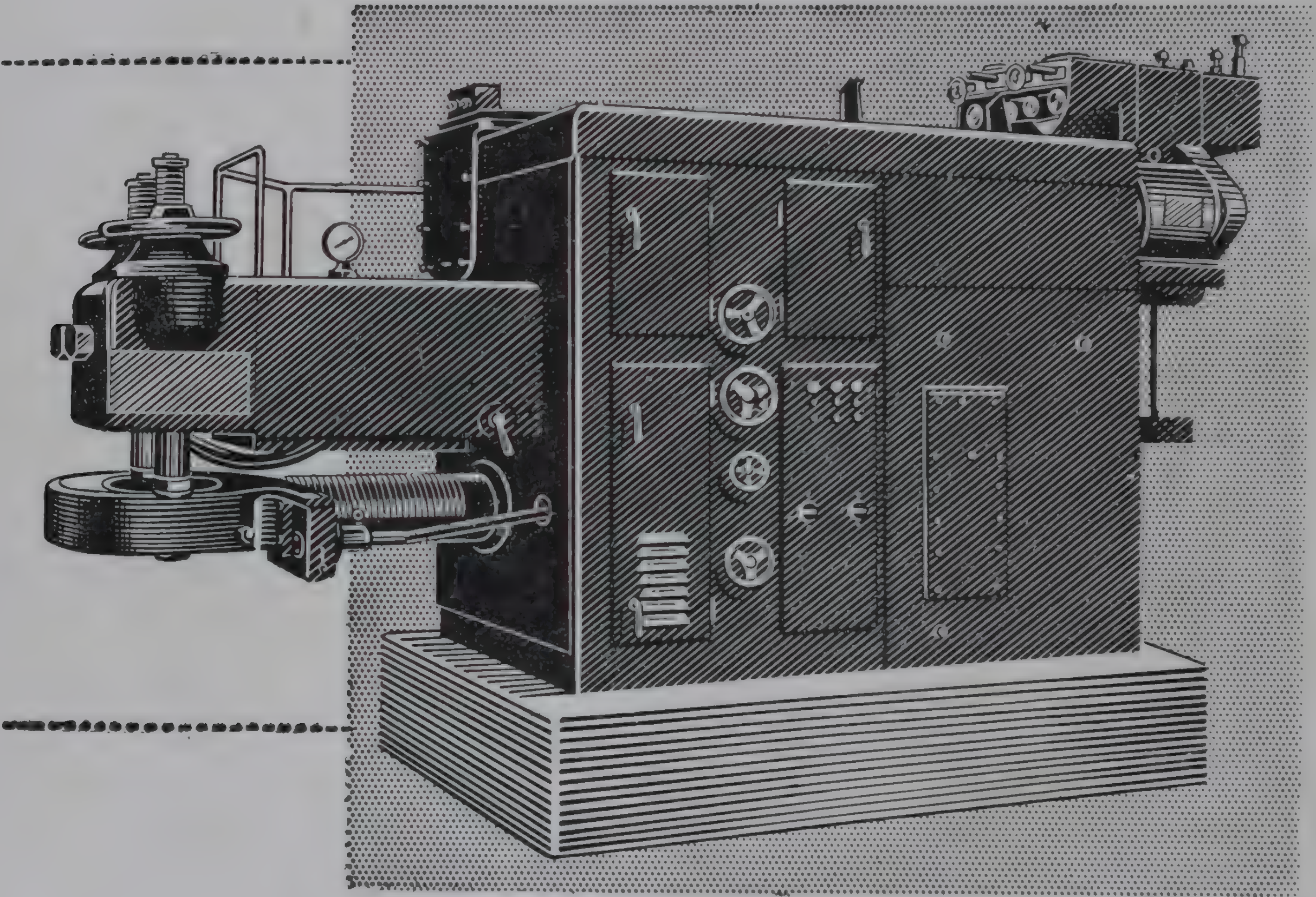

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PREPARATION OF EDIBLE FISH FLOUR FROM OIL-SARDINE (*CLUPEA LONGICEPS*)

By N. L. Lahiry, M. N. Moorjani, K. Visweswariah, S. R. Shurpalekar,
M. Swaminathan, A. Sreenivasan and V. Subrahmanyan

(*Central Food Technological Research Institute, Mysore*)

The wide prevalence of protein malnutrition among children in tropical and sub-tropical countries has been established during recent years.[1] Its prevention depends on increasing the supply and consumption of proteins in these countries and there are great possibilities for increasing the production and consumption of fish[2]. This will be dependent not only on greater catches or yields but also on providing better facilities for the preservation, transport and marketing. At present, frozen fish and canned fish are too expensive to be within the means of all the people. Traditional methods of preserving fish such as drying, smoking, and curing, have to be improved and their use encouraged. Another important method of preserving fish in the form of flour has recently been studied in different countries and holds considerable promise for the use of fish in child feeding[3] on a large-scale. The possibilities of using fish flour for supplementing the diets of children has also been stressed by FAO.[3]

Among the fish available in India, oil-sardine could be used for the production of fish flour for reasons given below.

(i) The present annual catch of oil-sardine is estimated at over 100,000 tons[4].

(ii) A substantial part of this quantity is used for the production of oil and the pressed residue rich in proteins is used as manure only.

(iii) The pressed residue obtained from dressed oil-sardine, will serve as a cheap raw material for the production of fish flour.

The present paper relates to studies on the standardization of a method for the preparation of edible fish flour from oil-sardine.

Experimental

Preparation of fish flour: Several processes have been developed, during recent years, to produce fish flour[5]. With FAO co-operation, three promising processes for manufacturing defatted and deodourized fish flour have been developed[3]. These include (1) *Dabsch process* depending on azeotropic extraction with light petroleum followed by repeated washings with alcohol for deodourization, (2) *Vogel process*, depending on treatment with alcohol or acetone containing alkali or acid, washing with alcohol or acetone and drying at reduced pressure, and (3) *Viobin process* based on azeotropic solvent extraction with ethylene dichloride, followed by washing with ethanol.

The method described in this paper for the preparation of edible fish flour from oil-sardine consists of the following steps:

(1) dressing, cooking and pressing of oil and water,

(2) drying, removal of scales and coarse-grinding,

(3) extraction with ethanol and drying in vacuo, and

(4) powdering and packaging.

The details of the process are described below:

Dressing, cooking and pressing oil and water: Oil-sardine caught in the west coast, was dressed to separate entrails consisting of head, tail, and viscera and scales. The dressed fish was just covered with water and cooked in a steam-jacketed kettle for 5 minutes. The cooked fish was pressed in a manually-operated screw press to expel most of the oil and water present in it.

Drying, removal of scales and coarse-grinding: The pressed material was dried to a moisture content of about 5 per cent in a through-flow drier at 55-60°C. The scales were removed from the dry material by blowing out in a current of air. The dried material was then coarsely ground for efficient solvent extraction.

Extraction with ethanol and drying in vacuum: The ground material was extracted with three times the volume of boiling ethanol (95 per cent) in a steam-jacketed circular type extractor fitted with automatic stirring device. The alcohol was drained off and the extraction was repeated four times in the above manner. The alcohol present in the residue was evaporated and condensed. The last traces of ethanol present in the meal were removed by drying the material in a vacuum drier at 80°C for two hours.

Powdering and packaging: The fat-free material obtained above, was powdered in a micropulveriser to pass through 80-mesh sieve and packed in the tins (1 gallon capacity) without leaving any head space, and sealed.

Results

Data collected on processing 100 lb. of oil-sardine are given in Table I.

TABLE I

	lbs.
Oil-sardine (starting material)	100
Entrails consisting of viscera, head, etc. (fat content 28.8%)	45
Muscle portion (fat 12.1%)	55
Pressed muscle cake	21.8
Pressed entrail cake	16.5
Alcohol extracted fish flour	10.0
Entrail cake (dry)	8.0

The product had a dull-white colour and was almost odourless. The results of chemical and bacteriological analysis and shelf-life of the product, are described below.

Chemical composition: The chemical composition of the fish flour was determined by the methods of AOAC[6] and the data are given in Table II. The results indicate that the product contained 84.24 per cent protein and 3.77 per cent calcium and only traces (0.12) of fat. The moisture content was 2.53 per cent.

TABLE II. *Chemical composition of fish flour from oil-sardine*
(values per 100 g.)

Constituent	Sample 1	Sample 2	Average
Moisture (g) ...	2.41	2.65	2.53
Protein (N × 6.25) g ...	83.43	85.05	84.24
Fat (g) ...	0.10	0.14	0.12
Ash (g) ...	9.85	10.55	10.20
Calcium (g) ...	3.62	3.92	3.77
Phosphorus (g) ...	2.18	2.34	2.26
Iron (mg) ...	8.8	11.6	10.2

Bacteriological quality: The fish flour was examined for total count, *B. coli* and *Salmonella* and pathogenic anaerobes by the methods of the American Public Health Association[7]. The product was free from *B. coli*, *Salmonella* and pathogenic anaerobes. The total counts were 10,000 and 15,000 in two batches of fish flour. No standard has, so far, been fixed for the total count of edible fish flour. The American standard[8] for good quality milk powder is 20,000 per g. and the Indian standard[9] for infant milk food is 30,000 per g. It is evident that the total count in fish flour is less than the standards suggested for good quality milk powder and infant milk food.

Shelf-life: The product packed in sealed cans (8 oz. capacity) was stored at 40°C for 12 months. No change in the colour of the product was observed. There was no development of rancidity or reversion of flavour.

Organoleptic evaluation: The fish flour was mixed with cereal and legume flours and several common food preparations were made. These were highly acceptable to a panel of tasters accustomed to eating fish.

Discussion

The results obtained in the present study, have shown that it is possible to prepare edible fish flour of good quality from oil-sardine. Since oil-sardine residue left after extraction of oil is at present wastefully utilized as manure, the cost of fish flour produced from this source is likely to be low. The entrail cake meal obtained as a by-product can be used as poultry feed. It is proposed to undertake pilot-plant trials for working out the cost of production of fish flour. The wide prevalence of protein malnutrition and population pressure have focused increasing attention on the importance of fish in world protein supplies. Fish flour containing over 80 per cent protein and 3 per cent calcium is obviously the most convenient form of preserving surplus fish during glut season in tropical and sub-tropical regions, when carefully prepared fish flour has a good shelf-life and has been found to be acceptable by consumers[3]. The results of studies on the protein efficiency ratio and supplementary value of fish flour and a protein food containing a 2:1:1 blend of groundnut flour, Bengalgram flour and fish flour to poor cereal diets are reported in the subsequent papers.

Summary

A process for the preparation of edible fish flour of good quality, with a low bacterial count, from oil-sardine has been described. The process consisted of four steps: (*i*) dressing, cooking and pressing of oil and water, (*ii*) drying and coarse-grinding, (*iii*) extraction with ethanol and drying *in vacuo* at 80°C and (*iv*) powdering and packaging.

The fish flour had a protein content of over 80 per cent, calcium content of 3.8 per cent and fat content of less than 0.5 per cent. It was free from *B. coli*, *Salmonella* and pathogenic anaerobes and the total count varied from 10,000 to 15,000 in 2 batches of the product.

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CHEMICAL COMPOSITION AND SHELF-LIFE OF A PROTEIN FOOD BASED ON LOW FAT GROUNDNUT FLOUR, BENGALGRAM FLOUR AND FISH FLOUR

By S. R. Shurpalekar, N. L. Lahiry, M. N. Moorjani, M. Swaminathan,
A. Sreenivasan and V. Subrahmanyan
(*Central Food Technological Research Institute, Mysore*)

Protein malnutrition is widely prevalent among weaned infants and young children in India and several Asian countries, in Africa and Latin America[1]. The important sources of protein-rich foods available in the above mentioned countries are oilseeds and oilseed meals, legumes, and fish[2]. Investigations carried out by several workers have shown that processed protein foods based on oilseed meals contain proteins of fairly high biological value and are effective in the treatment and prevention of protein malnutrition[3-5]. It has been shown by some workers that incorporation of a small percentage of skim milk powder containing proteins of high biological value brings about an improvement in the nutritive value of vegetable protein blends[6,7]. In a previous publication, the results of studies relating to the production of edible fish flour from oil sardine were reported[8]. Since fish flour contains proteins of high biological value and can be manufactured in several technically under-developed countries, it can be used in place of skim milk powder for enhancing the nutritive value of vegetable proteins[9,10]. The present paper describes the results obtained on the chemical composition and keeping quality of a protein food based on 2:1:1 blend of groundnut, Bengal gram and fish flours.

Experimental

Materials: Low-fat groundnut flour and Bengalgram flour used in this experiment were prepared according to Subrahmanyan *et al*[11]. The fish flour used in this experiment was the same as that described in the earlier paper of this series[8].

Seasoning premix: Condiments like coriander seeds (60 parts), black pepper (30 parts), turmeric

(9 parts) and asafoetida (1 part) were mixed together, lightly roasted with a small quantity of hydrogenated fat and powdered.

Forms of protein food: The protein food was prepared in two forms (1) unseasoned and (2) seasoned.

The unseasoned product consisted of a blend of low-fat groundnut flour (50 parts), roasted Bengalgram flour (25 parts) and fish flour (25 parts), fortified with vitamins (thiamine, riboflavin and vitamins A and D) and calcium salts. It was then flavoured with vanillin.

The seasoned product was prepared by adding seasoning premix (at 3 per cent level) and common salt (at 2 per cent level) to the unseasoned product prepared as above without the addition of vanillin.

Fortification with calcium salts and vitamins: Since the protein food was lacking in certain vitamins and calcium, it was fortified with calcium salts, thiamine, riboflavin and vitamins A and D.

Chemical composition: The chemical composition of the protein food was determined by A.O.A.C. methods[12]. The results are given in Table I.

Packing and storage: The protein food was packed in polythene bags which were sealed in cans (half pound capacity) and stored at 37°C for a period of 9 months. Control samples were kept at 0°C. The peroxide and acid values of the fat were determined periodically (once in two months) according to the methods used by Krishnamurthy *et al*[13]. Vitamin A and thiamine contents of the samples were also determined according to A.O.A.C. methods[12]. The organoleptic quality of the protein food was tested by a panel of 6 judges selected from among the Institute staff members. The score system adopted was as follows:

0 = as good as freshly made product,
1 = slight suspicion of off-flavour but highly acceptable,
2 = slight off-flavour but acceptable,
3 = definite off-flavour and unpalatable.

A product having a score of 2 or less was considered acceptable. The results are given in Table II.

TABLE I. *The chemical composition of fortified protein food† containing 2: 1: 1 blend of groundnut flour, Bengalgram and fish flour as compared with that of skim milk powder*
(values per 100g)

Constituent	Protein food containing fish flour		Skim milk powder
	Seasoned	Un-seasoned	
Moisture (g) ...	5.8	5.7	3.2
Protein (N×6.25) g. ...	49.2	51.6	36.1
Fat (g) ...	5.2	5.3	1.0
Calcium (g) ...	1.74	1.80	1.36
Phosphorus (g) ...	1.44	1.51	1.01
Thiamine (mg) ...	1.50	1.51	0.42
Riboflavin (mg) ...	2.15	2.10	1.52
Nicotinic acid (mg) ...	9.60	9.86	1.25
Vitamin A (I.U.) ...	3,000	3,000	Trace
,, D* (I.U.) ...	300	300	...

† Fortified with calcium salts and vitamins.
* Added values.

Results and Discussion

Table I shows the chemical composition of fortified protein food and skim milk powder. The protein content of the protein food was about 50 as compared with 36 per cent in skim milk powder. The protein food will provide nearly the same quantities of calcium and riboflavin as skim milk powder when compared on unit protein basis, and also substantial amounts of vitamins A and D.

Table II shows that the shelf-life of the protein food was satisfactory for a period of 8 months when stored at 37°C in hermetically sealed containers. The losses of vitamin A and thiamine at the end of 8 months' storage were about 25 per cent and 14 per cent respectively. The protein food stored in hermetically sealed containers at 37°C for a period of 8 months was organoleptically acceptable.

Summary

1. A process for the preparation of a protein food consisting of a 2:1:1 blend of low-fat

TABLE II. *Shelf-life of seasoned and unseasoned protein food† containing a 2: 1: 1: blend of low fat groundnut flour, Bengalgram flour and fish flour stored in sealed cans at 37°C*

Constituent	Initial		2 months		4 months		6 months		8 months	
	S	US	S	US	S	US	S	US	S	US
Free fatty acids (as% oleic acid in fat present in the food)	2.1	2.0	3.4	3.7	4.2	4.4	5.1	5.2	6.3	6.6
Peroxide value (millimols of thio per g. of fat present in the food)	1.5	1.7	3.3	3.8	4.6	5.4	5.7	7.2	6.8	8.7
Vitamin A (I·U.) ...	3,000	3,000	2,750	2,680	2,510	2,540	2,430	2,460	2,280	2,250
Thiamine (mg) ...	1.50	1.51	1.44	1.46	1.40	1.41	1.36	1.38	1·32	1.30

† Initial moisture content of the seasoned (S) and unseasoned (US) samples were 5.7 and 5.8 respectively.

groundnut flour, Bengalgram flour and fish flour and fortified with essential vitamins and calcium has been standardised.

2. The protein food is available in two forms (1) *seasoned*, for use in soups and savoury preparations and (2) *unseasoned*, for use in puddings and sweet preparations. It contains about 50 per cent protein and provides nearly the same amounts of calcium and riboflavin as skim milk powder when compared on the same protein basis and also substantial amounts of vitamins A and D.

3. Both the seasoned and unseasoned products kept well at 37°C in sealed containers for a period of 8 months. The loss of vitamin A was about 25 per cent and that of thiamine was about 14 per cent in samples stored at 37°C for 8 months.

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SUPPLEMENTARY VALUE OF PROTEINS OF FISH FLOUR TO THOSE OF GROUNDNUT FLOUR AND THE PROTEIN EFFICIENCY RATIO OF A PROTEIN FOOD CONTAINING GROUNDNUT, BENGALGRAM AND FISH FLOURS

By S. R. Shurpalekar, M. N. Moorjani, N. L. Lahiry, K. Indiramma, M. Swaminathan,
A. Sreenivasan and V. Subrahmanyan

(Central Food Technological Research Institute, Mysore)

The important sources of protein rich foods available in India are the various oilseeds and legumes[1]. There is considerable scope for increasing fish production and for the manufacture of fish flour in India[2]. It is generally recognized that all vegetable proteins are partially deficient in one or more essential amino acids[3]. Even though the proteins of oilseeds and legumes supplement those of cereals to a significant extent, they are nevertheless, less effective, in this respect than the proteins of milk, fish and other animal foods[3-5]. There is evidence indicating that incorporation of skim milk powder to the extent of 20 per cent along with groundnut flour or Bengalgram flour improves to a significant extent the protein efficiency ratio of the proteins of the latter two[6]. In the present investigation, the supplementary value of the proteins of fish flour to those of groundnut flour and the protein efficiency ratio of a protein food containing groundnut, Bengalgram and fish flours has been studied.

Experimental

Materials: Groundnut flour and roasted Bengalgram flour were prepared according to Subrahmanyan *et al*[7]. Fish flour used in the present experiment was the same as that described in an earlier paper of this series[2]. The protein food was prepared[8] by mixing low-fat groundnut flour (50 parts), roasted Bengalgram flour (25 parts) and fish flour (25 parts) and fortifying with vitamins A and D, thiamine, riboflavin and calcium salts. Good quality spray-dried skim milk powder was used in the experiments.

Chemical composition: The moisture and nitrogen contents of the different foods were determined according to the methods of A.O.A.C.[9] The essential amino acids of the proteins of the different foods used in this study were determined according to the following methods:

methionine according to Horn *et al.*,[10];
histidine according to Macpherson[11];
tryptophane by the method of Spies[12].

other essential amino acids according to chromatographic method of Krishnamurthy and Swaminathan[13] with the modification that unidimensional chromatographic technique (descending type) with a mixture of teritiary amyl alcohol and benzyl alcohol was used for the separation of leucine and isoleucine.

The results are given in Tables I and II.

TABLE I. *Moisture and protein content of protein rich foods used in the experiment*

Material	Moisture %	Protein (N × 6.25) %
Fish flour	2.5	84.2
Groundnut flour	6.5	49.5
Protein food containing fish flour	5.4	51.6
Indian multipurpose food ...	6.8	42.3
Skim milk powder	3.2	36.1

Protein efficiency ratio (P.E.R.): The protein efficiency ratios of the individual proteins and the protein food at 10 per cent level of protein intake were determined by the rat growth method of Osborne, Mendel and Ferry[14]. The experiments were carried out in two series.

Weanling male albino rats (28 days old) from the laboratory stock colony, weighing 40-45 g. were allotted to different groups according to simple randomized block design, ignoring litters. The protein content in all the diets was maintained at approximately 10 per cent level on dry weight

TABLE II. *Essential amino acid composition of protein-rich foods used in the experiment* (g/16 g.N)

Essential amino acid	Groundnut flour	Fish flour	Protein food containing fish flour	Indian multi-purpose food	Skim milk powder
Arginine ...	10.7	5.6	8.6	8.1	3.7
Histidine ...	2.4	2.8	2.7	2.5	2.7
Lysine ...	3.5	9.6	6.1	4.1	7.9
Leucine ...	6.1	7.2	6.8	6.3	6.5
Isoleucine ...	4.1	5.2	4.9	4.4	10.0
Methionine ...	0.9	2.8	1.7	1.0	2.5
Cystine ...	1.5	1.5	1.6	1.5	0.9
Phenylalanine ...	5.1	3.8	4.6	5.0	4.9
Tyrosine ...	3.6	2.9	3.4	3.6	5.2
Threonine ...	2.7	5.8	3.9	2.8	4.7
Tryptophane ...	1.1	1.1	1.1	1.0	1.4
Valine ...	4.9	5.4	5.3	5.0	7.0

basis. The diets were adequate in other nutrients and the compositions of the diets were similar to those used by Tasker *et al*[15]. The diets were cooked with three times their weight of water by steaming for 10 minutes, and fed *ad lib* to the rats. Records of food intake were maintained for each animal. The rats were weighed weekly. Data regarding the protein efficiency ratios calculated for a period of 4 weeks are given in Table III.

Results and Discussion

The protein efficiency ratio of the proteins of fish flour (2.92) was found to be nearly the same as that of the proteins of skim milk powder (3.04). Blends of groundnut proteins and fish proteins in the ratios of 3:1 and 1:1 possessed P.E.R. of 2.08 and 2.48 respectively as compared with a value of 1.50 obtained for groundnut protein thus indicating that the proteins of fish flour supplement to a significant extent those of groundnut flour. It is also of interest to note that the P.E.R.

TABLE III. *Supplementary relations between the proteins of fish flour and groundnut flour and the protein efficiency ratio of blends containing fish flour as compared with Indian multipurpose food and skim milk powder*

Source of protein in the diet	Protein contributed (%)	Average initial body weight (g)	Average gain in body weight (g)	Average protein intake (g)	Protein efficiency ratio (4 weeks)	
Series I[1]						
Fish flour ...	10	43.7	84.3	28.8	2.92	±0.101 (20 d.f.)
Groundnut flour ...	10	43.7	41.8	27.6	1.50	
Groundnut flour ... + fish flour ...	5.0 5.0	44.0	68.2	27.4	2.48	
Groundnut flour ... + fish flour ...	7.5 2.5	43.8	54.2	25.9	2.08	
Skim milk powder ...	10	43.8	83.8	27.2	3.04	
	Critical difference at		5% level		0.298	
	,,		1% level		0.407	
	,,		0.1% level		0.551	
Series II[2]						
Indian multipurpose food ...	10	41.4	49.1	27.4	1.79	±0.06 (12 d.f.)
Protein food containing fish flour ...	10	41.4	69.7	27.2	2.56	
Skim milk powder ...	10	41.4	84.1	27.6	3.05	
	Critical difference at		5% level		0.19	
	,,		1% level		0.26	
	,,		0.1% level		0.37	

[1] Each group contained 6 male rats.

[2] Each group contained 7 male rats.

of the proteins of a 2:1:1 blend of groundnut flour, Bengalgram flour and fish flour (2.56) was significantly higher than that (1.79) obtained for Indian multipurpose food (a 3:1 blend of groundnut flour and Bengalgram flour). The results obtained in the present studies are of considerable importance to many technically underdeveloped countries where protein malnutrition is widely prevalent, as they have shown the possibility of obtaining protein blends of high nutritive value from locally available protein resources.

Summary

1. The P.E.R. of fish flour from oil sardine (2.92) was nearly of the same order as that of the proteins of skim milk powder (3.04) at 10 per cent level of protein intake over a period of 4 weeks.

2. The P.E.R. of blends of groundnut flour and fish flour proteins in the ratio of 3.1 and 1:1 were 2.08 and 2.48 respectively as compared with a value of 1.5 obtained for groundnut flour.

3. The P.E.R. of the proteins of a 2:1:1 blend of groundnut flour, Bengalgram flour and fish flour (2.56) was significantly higher than that (1.79) of a 3:1 blend of low-fat groundnut flour and Bengalgram flour (Indian multipurpose food).

Acknowledgment

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SUPPLEMENTARY VALUE OF FISH FLOUR AND A PROTEIN FOOD CONTAINING LOW FAT GROUNDNUT FLOUR, BENGALGRAM FLOUR AND FISH FLOUR TO POOR RICE DIET

By S. R. Shurpalekar, A. A. Joseph, N. L. Lahiry, M. N. Moorjani, A. N. Sankaran, M. Swaminathan, A. Sreenivasan and V. Subrahmanyan

(Central Food Technological Research Institute Mysore)

Rice forms the staple food in the diets of approximately half the worlds' population. Diet surveys carried out in different rice-eating areas in India have shown that rice supplies about 70-80 per cent of the calories in the diets of the people[1]. Rice is also the most important source of proteins, minerals, and B-complex vitamins in poor dietaries[2]. The diets consumed by weaned infants and young children of the low income groups of the population consist of cooked rice and rice gruel, along with small quantities of pulses, and vegetables[3-5]. Such diets have a low protein content and are deficient in calcium and certain vitamins and do not promote optimum growth in children. Protein malnutrition and vitamin deficiency diseases are fairly common among malnourished children in India[5]. The need for providing a low cost protein supplement of high nutritive value based on locally available protein-rich foods has been pointed out by several workers and International agencies[6]. In the present investigation, the supplementary value of a protein food consisting of 2:1:1 blend of low fat groundnut flour, Bengalgram flour and fish flour to poor rice diet as compared with fortified fish flour, has been studied.

Table I. *Chemical composition of fortified fish flour and protein food containing fish flour as compared with skim milk powder*

(values per 100 g)

Constituent		Fish flour[1]	Protein food[2] (unseasoned)	Skim milk powder[3]
Moisture (g)	...	2.5	5.7	3.2
Protein ($N \times 6.25$) (g)	...	84.2	50.6	36.1
Fat (g)	...	0.12	5.3	1.0
Calcium (g)	...	3.77	1.80	1.36
Phosphorus (g)	...	2.26	1.51	1.01
Thiamine (mg)	...	2.40	1.51	1.10
Riboflavin (mg)	...	3.65	2.10	1.52
Nicotinic acid (mg)	...	16.50	9.86	6.36
Vitamin A (I.U.)	...	5000	3000	2000
Vitamin D* (I.U.)	...	500	300	200

[1] Fortified with riboflavin, vitamins A & D.

[2] Fortified with calcium salts, riboflavin, vitamins A & D.

[3] Fortified with thiamine, nicotinic acid, vitamins A & D.

* Added values.

Experimental

Materials: The samples of fish flour and protein food used in this study were the same as those described in an earlier paper of this series.[7] The chemical composition of fortified fish flour and protein food as compared with skim milk powder was determined by A.O.A.C. methods[8]. The results are given in Table I.

Animal experiments: The supplementary value of fish flour and the protein food when incorporated to provide 5 per cent extra protein in the diet, was determined by growth experiments on albino rats. Freshly weaned albino rats weighing about 45 g. (12 in each group, distributed according to sex and body weight) were allotted to different groups according to randomized block design ignoring litters. The animals were housed individually in raised wire screen-bottom cages and fed *ad lib* on the different diets (Table II). Another group of weanling rats weighing about 45g. each was used to determine the initial body composition. The diets were mixed with three times their weight of water, cooked in steam for 10 minutes and fed to the rats. Records of

TABLE II. *Percentage composition of experimental diets*

Constituents	Poor rice diet	Poor rice diet + protein food containing fish flour	Poor rice diet + fish flour
Rice	78.5	68.5	72.6
Protein food containing fish flour	...	10.0	...
Fish flour	...	...	5.9
Red gram dhal (*Cajanus cajan*) ...	5.0	5.0	5.0
Groundnut oil	5.0	5.0	5.0
Skim milk powder	0.9	0.9	0.9
Common salt	0.3	0.3	0.3
Non-leafy vegetables: potatoes and brinjal (*Solanum melongina*)	8.2	8.2	8.2
Leafy vegetables (*Amaranthus gangeticus*)	2.1	2.1	2.1

daily food intake were kept for all the groups and the rats were weighed weekly. After 8 weeks, the haemoglobin and red blood cell count in the blood of the rats were determined according to methods used by Venkata Rao *et al*[9]. The animals were then sacrificed and the livers removed. The histological examination of the livers of female rats was carried out according to the methods described by Venkata Rao *et al*[9]. The moisture, fat and nitrogen contents of the livers and carcasses were determined according to Venkata Rao *et al*[9]. The results are given in Tables III—V.

Results

Weight gain and composition of blood: The results presented in Table III show that the fish flour and the protein food when incorporated in poor rice diet to provide 5 per cent extra protein produced a highly significant ($P<0.001$) increase in the weight of rats. There were no significant differences, in the mean increases in weight of rats receiving the fish flour or the protein food. The mean haemoglobin levels of rats receiving the supplement of fish flour or the protein food were significantly greater than those of rats fed on the control rice diet.

Composition of liver and carcass: Table IV shows the results of analysis of the livers and carcasses of the rats fed on the different diets. No significant differences were observed in the mean fat and protein contents of the livers and carcasses of the rats receiving the supplement of protein food or fish flour. The mean fat content of the livers of rats fed on the control rice diet was significantly higher and the protein content significantly lower than the corresponding values for the rats receiving the protein supplements. There were no significant differences in the mean protein contents of the carcasses of the rats fed on the rice diet and the same supplemented with fish flour or protein food.

TABLE III. *Growth and composition of blood of rats fed on poor rice diet supplemented with fish flour and protein food containing fish flour*

(Period of experiment: 8 weeks; mean values for 6 male and 6 female rats in each group)

Group	Diet	Protein content of diet[1] %	Initial body weight (g)	Daily food intake[1] (g)	Weekly gain in body wt. (g)		Haemoglobin (g/100cc)		Red blood cells (10^6/cu.mm.)	
A.	Poor rice diet	8.58	47.0	6.2	6.6	±0.33 (20 d.f.)	14.04	±0.17 (20 d.f.)	7.70	±0.13 (20 d.f.)
B.	,, + protein food containing fish flour ...	13.24	47.0	9.5	15.3		14.90		7.99	
C.	,, + fish flour ...	13.12	47.0	9.6	16.3		14.98		8.05	
	Critical difference at 5% level				0.98		0.50		0.39	
	,, ,, 1% ,,				1.34		0.68		...	
	,, ,, 0.1% ,,				1.81		0.92		...	

[1] Expressed on moisture-free basis.

TABLE IV. *Chemical composition of livers and carcasses of rats fed on poor rice diet supplemented with fish flour and protein food containing fish flour*
(Experimental period: 8 weeks; mean values for 6 males in each group)

Group	Diet	Average body weight (g)		Weight of fresh liver (g)	Liver						Carcass					
		Initial	Final		Moisture %		Fat %		Protein %		Moisture %		Fat %		Protein %	
A	Poor rice diet	47.5	101.5	4.42	70.63	±0.19 (10 d.f.)	3.81	±0.14 (10 d.f.)	16.67	±0.46 (10 d.f.)	61.69	±0.48 (10 d.f.)	14.23	±0.59 (10 d.f.)	17.78	±0.38 (10 d.f.)
B	Poor rice diet+ protein food containing fish flour	47.5	196.7	7.55	70.58		3.04		18.36		58.64		17.28		18.79	
C	Poor rice diet+ fish flour	47.5	202.5	7.48	70.75		3.25		18.48		57.84		17.73		18.88	
	Critical difference at 5% level				0.61		0.43		1.44		1.52		1.87		1.19	
	„ 1% „				0.87		0.62		2.05		2.17		2.66		1.69	
	„ 1% „				...		...		...		3.14		3.85		2.45	

TABLE V. *Intake and retention of protein in rats fed on poor rice diet supplemented with fish flour and protein food containing fish flour*
(Experimental period: 8 weeks; mean values for 6 males in each group)

Diet	Total protein intake (g)	Total Increase in body weight (g)	Initial body protein (g)	Total body protein (g)	Protein retained (g)	Protein retained per 100 g. increase in body weight	
A. Poor rice diet ...	26.4	54.0	8.47	18.04	9.57	17.83	± 0.62 (10 d.f.)
B. „ + protein food containing fish flour	64.8	149.2	8.47	37.05	28.58	19.16	
C. „ + fish flour ...	65.3	155.0	8.47	37.98	29.51	19.03	
Critical difference at	5% level					1.94	
„	1% „					2.76	
„	0.1% „					3.99	

Histological structure of liver: Livers of animals fed on the rice diet showed a mild to moderate degree of parenchymal damage of the protein deficiency type. Varying degrees of cytoplasmic vacuolation of the protein deficiency type were observed. Fatty infiltration was not observed. The liver sections of rats receiving the protein supplements were normal indicating thereby that incorporation of extra protein to the extent of 5 per cent in the rice diet made up the protein deficiency in the diet.

Intake and retention of protein: Table V shows the intake and retention of protein by the rats fed on different diets. No significant differences were observed in the mean retentions of protein per 100 g. increase in body weight of rats fed on the rice diet or the same supplemented with fish flour or the protein food.

Discussion

The results show that a protein food based on a blend of low fat groundnut flour, Bengalgram flour and fish flour was as effective as fish flour in promoting the growth of rats when the two foods provided 5 per cent extra protein in the poor rice diet. It is possible that since fish flour proteins are rich in lysine and threonine, it may prove effective in supplementing poor Indian diets when incorporated even at lower levels. The results of studies on the effect of supplementing poor Indian diets based on different cereals and millets with fish flour at lower levels to provide about 2.5 per cent extra protein are reported in the following paper[10] of this series.

Summary

1. Supplementation of a poor Indian rice diet with fish flour, or a protein food based on 2:1:1 blend of groundnut flour, Bengalgram flour and fish flour to provide about 5 per cent extra protein in the diet resulted in a highly significant ($P<0.001$) increase in the growth of rats. There were no significant differences in the mean weekly growth rates between the two protein supplemented diets.

2. The mean fat content of the livers of rats fed on the control rice diet was significantly higher and the mean protein content significantly lower than the corresponding values for the rats receiving diets containing the protein supplements. Livers of animals fed on the rice diet showed mild to moderate degree of parenchymal damage of the protein deficiency type, while those of rats receiving the protein supplements were quite normal.

3. No significant differences were observed in the mean retentions of protein per 100 g. increase in body weight of rats fed on the rice diet or the same supplemented with protein foods.

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Authors' thanks are due to Miss K. Indiramma and Mr N. Nataraja for help in the statistical analysis of results.

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SUPPLEMENTARY VALUE OF FISH FLOUR FORTIFIED WITH VITAMINS TO POOR INDIAN DIETS BASED ON DIFFERENT CEREALS AND MILLETS

By S. R. Shurpalekar, A. A. Joseph, M. N. Moorjani, N. L. Lahiry, K. Indiramma, M. Swaminathan, A. Sreenivasan and V. Subrahmanyan

(*Central Food Technological Research Institute, Mysore*)

The diets consumed by a vast majority of the people belonging to the low income groups in India, consist predominantly of cereals and millets and contain only small quantities of pulses, vegetables and fats and negligible amounts of milk and other protein rich animal foods[1]. The diets, in general, have been found to be deficient in vitamin A, riboflavin, calcium and proteins of high biological value[2]. Experiments on albino rats have shown that the growth-promoting values of poor Indian diets based on different cereals and millets are low, as compared with that of well-balanced stock diet[3]. Aykroyd and Krishnan[4] reported that whole milk powder and skim milk powder were highly effective while pulses were only slightly effective in improving the growth promoting value of the poor rice diet. Kuppuswamy *et al*[5]., reported that Indian multipurpose food based on a 3:1 blend of low fat groundnut and Bengalgram flours when incorporated at 12.5 per cent level (providing about 5 per cent extra protein) in the diet was highly effective in increasing the growth promoting value of poor Indian diets. In an earlier publication of this series[6], it was reported that fish flour and a protein food based on 2:1:1 blend of low fat groundnut flour, Bengalgram flour and fish flour, and fortified with calcium salts and certain vitamins, when incorporated in the diet to provide 5 per cent extra protein, produced a marked improvement in the growth promoting value of poor rice diet. Sure[7] and Metta[8] reported that fish flour proteins when incorporated at as low a level as 2 per cent were highly effective in improving the nutritive value of cereal proteins. It was, therefore, considered of interest to study the supplementary value of fortified fish flour at lower levels (providing about 2.5 per cent extra protein) to poor Indian diets based on different cereals.

Experimental

The fortified fish flour used in the experiment was the same as that used in earlier investigations[6]. The supplementary value of fortified fish flour (at 3 per cent level) and skim milk powder (at 7 per cent level) to poor Indian diets based on rice, wheat, ragi and jowar was studied by the rat growth method. The two supplements provided about 2.5 per cent extra protein and substantial amounts of calcium to the diets. The composition of the poor vegetarian diets is given in Table I. Groups of freshly weaned albino rats (10 in each group and distributed equally according to sex, litter mates and body weight on a randomized block design) were housed in individual cages with raised wire screen—bottoms. They were fed *ad lib* on the poor Indian diets based on rice, wheat, ragi and jowar and the same diets in which 3 per cent and 7 per cent of the cereal or millet was replaced by the fortified fish flour and skim milk powder respectively. The methods used

Table I. *Percentage compositian of experimental diets*

Ingredients	Poor Indian diets	Poor Indian diets + fish flour	Poor Indian diets + skim milk powder
Cereal or millet ...	78.5	75.5	71.5
Fish flour (fortified with vitamins)...	...	3.0	...
Skim milk powder (fortified with vitamins A & D) ...	...	...	7.0
Red gram dhal (*Cajanus indicus*) ...	5.0	5.0	5.0
Groundnut oil ...	5.0	5.0	5.0
Skim milk powder ...	0.9	0.9	0.9
Common salt ...	0.3	0.3	0.3
Non-leafy vegetables: potatoes, and brinjal (*Solanum melongena*)	8.2	8.2	8.2
Leafy vegetables (*Amaranthus gangeticus*) ...	2.1	2.1	2.1

TABLE II. *Percentage composition of experimental diets*

Constituents	Poor rice diet	Poor rice diet + protein food containing fish flour	Poor rice diet + fish flour
Rice	78.5	68.5	72.6
Protein food containing fish flour	...	10.0	...
Fish flour	...	...	5.9
Red gram dhal (*Cajanus cajan*) ...	5.0	5.0	5.0
Groundnut oil	5.0	5.0	5.0
Skim milk powder	0.9	0.9	0.9
Common salt	0.3	0.3	0.3
Non-leafy vegetables: potatoes and brinjal (*Solanum melongina*)	8.2	8.2	8.2
Leafy vegetables (*Amaranthus gangeticus*)	2.1	2.1	2.1

daily food intake were kept for all the groups and the rats were weighed weekly. After 8 weeks, the haemoglobin and red blood cell count in the blood of the rats were determined according to methods used by Venkata Rao *et al*[9]. The animals were then sacrificed and the livers removed. The histological examination of the livers of female rats was carried out according to the methods described by Venkata Rao *et al*[9]. The moisture, fat and nitrogen contents of the livers and carcasses were determined according to Venkata Rao *et al*[9]. The results are given in Tables III—V.

Results

Weight gain and composition of blood: The results presented in Table III show that the fish flour and the protein food when incorporated in poor rice diet to provide 5 per cent extra protein produced a highly significant ($P<0.001$) increase in the weight of rats. There were no significant differences, in the mean increases in weight of rats receiving the fish flour or the protein food. The mean haemoglobin levels of rats receiving the supplement of fish flour or the protein food were significantly greater than those of rats fed on the control rice diet.

Composition of liver and carcass: Table IV shows the results of analysis of the livers and carcasses of the rats fed on the different diets. No significant differences were observed in the mean fat and protein contents of the livers and carcasses of the rats receiving the supplement of protein food or fish flour. The mean fat content of the livers of rats fed on the control rice diet was significantly higher and the protein content significantly lower than the corresponding values for the rats receiving the protein supplements. There were no significant differences in the mean protein contents of the carcasses of the rats fed on the rice diet and the same supplemented with fish flour or protein food.

TABLE III. *Growth and composition of blood of rats fed on poor rice diet supplemented with fish flour and protein food containing fish flour*

(Period of experiment: 8 weeks; mean values for 6 male and 6 female rats in each group)

Group	Diet	Protein content of diet[1] %	Initial body weight (g)	Daily food intake[1] (g)	Weekly gain in body wt. (g)	Haemoglobin (g/100cc)	Red blood cells (10^6/cu.mm.)
A.	Poor rice diet	8.58	47.0	6.2	6.6	14.04	7.70
B.	,, + protein food containing fish flour ...	13.24	47.0	9.5	15.3 ±0.33 (20 d.f.)	14.90 ±0.17 (20 d.f.)	7.99 ±0.13 (20 d.f.)
C.	,, + fish flour ...	13.12	47.0	9.6	16.3	14.98	8.05
	Critical difference at 5% level				0.98	0.50	0.39
	,, ,, 1% ,,				1.34	0.68	...
	,, ,, 0.1% ,,				1.81	0.92	...

[1] Expressed on moisture-free basis.

SUPPLEMENTARY VALUE OF FISH FLOUR FORTIFIED WITH VITAMINS TO POOR INDIAN DIETS BASED ON DIFFERENT CEREALS AND MILLETS

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The diets consumed by a vast majority of the people belonging to the low income groups in India, consist predominantly of cereals and millets and contain only small quantities of pulses, vegetables and fats and negligible amounts of milk and other protein rich animal foods[1]. The diets, in general, have been found to be deficient in vitamin A, riboflavin, calcium and proteins of high biological value[2]. Experiments on albino rats have shown that the growth-promoting values of poor Indian diets based on different cereals and millets are low, as compared with that of well-balanced stock diet[3]. Aykroyd and Krishnan[4] reported that whole milk powder and skim milk powder were highly effective while pulses were only slightly effective in improving the growth promoting value of the poor rice diet. Kuppuswamy *et al*[5]., reported that Indian multipurpose food based on a 3:1 blend of low fat groundnut and Bengalgram flours when incorporated at 12.5 per cent level (providing about 5 per cent extra protein) in the diet was highly effective in increasing the growth promoting value of poor Indian diets. In an earlier publication of this series[6], it was reported that fish flour and a protein food based on 2:1:1 blend of low fat groundnut flour, Bengalgram flour and fish flour, and fortified with calcium salts and certain vitamins, when incorporated in the diet to provide 5 per cent extra protein, produced a marked improvement in the growth promoting value of poor rice diet. Sure[7] and Metta[8] reported that fish flour proteins when incorporated at as low a level as 2 per cent were highly effective in improving the nutritive value of cereal proteins. It was, therefore, considered of interest to study the supplementary value of fortified fish flour at lower levels (providing about 2.5 per cent extra protein) to poor Indian diets based on different cereals.

Experimental

The fortified fish flour used in the experiment was the same as that used in earlier investigations[6]. The supplementary value of fortified fish flour (at 3 per cent level) and skim milk powder (at 7 per cent level) to poor Indian diets based on rice, wheat, ragi and jowar was studied by the rat growth method. The two supplements provided about 2.5 per cent extra protein and substantial amounts of calcium to the diets. The composition of the poor vegetarian diets is given in Table I. Groups of freshly weaned albino rats (10 in each group and distributed equally according to sex, litter mates and body weight on a randomized block design) were housed in individual cages with raised wire screen—bottoms. They were fed *ad lib* on the poor Indian diets based on rice, wheat, ragi and jowar and the same diets in which 3 per cent and 7 per cent of the cereal or millet was replaced by the fortified fish flour and skim milk powder respectively. The methods used

TABLE I. *Percentage compositian of experimental diets*

Ingredients	Poor Indian diets	Poor Indian diets + fish flour	Poor Indian diets + skim milk powder
Cereal or millet ...	78.5	75.5	71.5
Fish flour (fortified with vitamins)...	...	3.0	...
Skim milk powder (fortified with vitamins A & D) ...	...	...	7.0
Red gram dhal (*Cajanus indicus*) ...	5.0	5.0	5.0
Groundnut oil ...	5.0	5.0	5.0
Skim milk powder ...	0.9	0.9	0.9
Common salt ...	0.3	0.3	0.3
Non-leafy vegetables: potatoes, and brinjal (*Solanum melongena*)	8.2	8.2	8.2
Leafy vegetables (*Amaranthus gangeticus*) ...	2.1	2.1	2.1

SUPPLEMENTARY VALUE OF FISH FLOUR AND A PROTEIN FOOD CONTAINING LOW-FAT GROUNDNUT FLOUR, BENGALGRAM FLOUR AND FISH FLOUR TO A MAIZE-TAPIOCA DIET

By S. R. Shurpalekar, A. Paul Jayaraj, M. N. Moorjani, N. L. Lahiry, A. N. Sankaran, M. Swaminathan, A. Sreenivasan and V. Subrahmanyan

(Centrol Food Technological Research Institute, Mysore)

The diets consumed by children belonging to the low income groups of the population in several tropical and sub-tropical countries consist largely of cereals, roots and tubers and contain negligible amounts of protein rich foods. Such diets are deficient in proteins, certain vitamins and minerals[1-5]. The incidence of protein malnutrition is particularly high in regions where diets based on maize and tapioca are consumed[3]. The problem of providing low-cost nutritious food supplements to the diets of children has been engaging the attention of nutrition workers in several countries and also of certain International organisations such as FAO, WHO and UNICEF[6,7]. The most important protein-rich foods available in different underdeveloped countries include the various oilseed meals and legumes[6,7]. Fish is also available in abundance in certain countries[8]. Studies relating to the production and nutritive value of fish flour and a protein food based on 2:1:1 blend of groundnut flour, Bengalgram flour and fish flour have been reported in earlier papers of this series[9-12]. In the present investigation, the supplementary value of fish flour and a protein food containing a 2:1:1 blend of low fat groundnut flour, Bengalgram flour and fish flour as compared with skim milk powder to a low-protein diet based on maize and tapioca has been studied.

Experimental

Materials and methods: Maize flour (100 per cent extraction) used in the experiments was prepared by powdering clean white maize (local variety) in a flour mill to pass through a 50 mesh sieve. Tapioca flour was prepared from fresh tapioca roots according to the method of Subrahmanyan *et al*[13]. The samples of fish flour, protein food containing fish flour, and skim milk powder used in this experiment were the same as those described in a previous paper[11].

Animal experiments: The supplementary value of fish flour and protein food containing fish flour and skim milk powder (when incorporated to provide 10 per cent extra protein) to a maize-tapioca diet was determined by growth experiments on albino rats. The composition of the experimental diets is shown in Table I. Freshly weaned albino rats, weighing about 45 g. (12 in each group and distributed equally according to sex and body weight) were allotted to different groups according to randomized block design, ignoring litters. The animals were housed individually in raised wire screen-bottom cages and fed *ad lib* on the experimental diets. The diets were mixed with three times their weight

Table I. *Percentage composition of experimental diets*

Ingredients	Maize-tapioca diet (A)	Maize-tapioca diet + fish flour (B)	Maize-tapioca diet + Protein food containing fish flour (C)	Maize-tapioca diet + skim milk powder (D)
Maize ...	43.0	37.1	33.0	29.8
Tapioca ...	43.0	37.1	33.0	29.8
Fish flour ...	...	11.8	...	...
Protein food containing fish flour	...	...	20.0	...
Skim milk powder	...	...	...	26.4
Groundnut oil ...	10.0	10.0	10.0	10.0
Salt mixture[1] ...	2.0	2.0	2.0	10.0
Vitaminised starch[2]	1.0	1.0	1.0	1.0
Common salt ...	1.0	1.0	1.0	1.0

[1] Hubbel, Mendel and Wakeman salt mixture.

[2] Composition of vitaminised starch was the same as that used by Shurpalakar *et al.*[16]

of water, cooked in steam for 10 minutes and fed to the rats. One group of weanling rats weighing about 40 g. was used for determining the initial body composition. Records of the daily food intake were maintained and the rats were weighed weekly. After feeding for 8 weeks, the haemoglobin and red blood cell count in the blood of animals were determined according to Venkata Rao *et al*[14]. The animals were sacrificed and the livers were removed. Histological examination of the livers was carried out according to Venkata Rao *et al*[14]. The moisture, fat and nitrogen contents of the livers and carcasses of rats were determined according to the methods used by Venkata Rao, *et al*[14]. The retention of protein in the carcass of rats receiving the different diets over a period of 8 weeks was calculated by subtracting the initial protein contents from the final protein contents of the carcass according to Shurpalekar *et al*[15]. The results are given in Tables II, III and IV.

Results

Growth and composition of blood: Table II shows that incorporation of fish flour, protein food or skim milk powder in maize-tapioca diet to provide 10 per cent extra protein resulted in a highly significant increase ($P<0.001$) in the growth of rats. There was no significant difference in the growth rates of rats receiving the supplement of fish flour, protein food or skim milk powder. The haemoglobin and red blood cell count of rats receiving the supplements of fish flour or protein food were significantly greater ($P<0.001$) than those of rats fed on the maize-tapioca diet.

Composition of liver and carcass: No significant differences were observed in the mean fat contents of the livers and mean protein contents of the livers and carcasses of rats receiving the supplement of fish flour, the protein food or skim milk powder (Table III). The mean fat content of the livers of rats fed on the maize-tapioca diet was significantly higher ($P<0.001$) and the mean protein content significantly lower ($P<0.001$) than those of rats receiving the protein supplements. The mean protein content of the carcass of rats fed on maize-tapioca diet was also significantly lower ($P<0.001$) than that of animals receiving the protein supplements.

Histological structure of liver: Livers of animals fed on the maize-tapioca diet showed a mild to moderate degree of parenchymal damage of the protein-deficiency type. Varying degrees of cytoplasmic vacuolation due to protein deficiency were observed. Frozen sections stained with Sudan IV showed abundant stainable fat around periportal areas. Necrosis of the liver cells was absent. The liver sections of rats receiving the supplement of fish flour, protein food or skim

TABLE II. *Growth and composition of blood of rats fed on maize-tapioca diet supplemented with different protein foods*
Period of experiment: 8 weeks; mean values for 12 rats (6 males and 6 females) in each group

Group	Diet	Protein content[1] of diet %	Initial body weight (g)	Daily food intake (g)	Weekly gain in body weight (g)		Haemoglobin (g/100 cc)		Red blood cells (10^6/cu.mm)	
A	Maize-tapioca—Control ...	5.64	46.9	6.6	1.8		11.17		5.16	± 0.14 (30 d.f.)
B	Control + fish flour ...	14.62	46.7	9.3	19.7	± 0.28 (20 d.f.)	14.77	± 0.22 (30 d.f.)	7.89	
C	Control+protein food containing fish flour ...	15.02	46.7	9.7	19.3		14.94		7.84	
D	Control + skim milk powder ...	14.54	46.7	9.5	19.3		14.69		7.69	
	Critical difference at		5% level ...		0.84		0.62		0.41	
	,, ,,		1% level ...		1.14		0.84		0.55	
	,, ,,		0.1% level ...		1.55		1.11		0.73	

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[1] Values expressed on moisture-free basis.

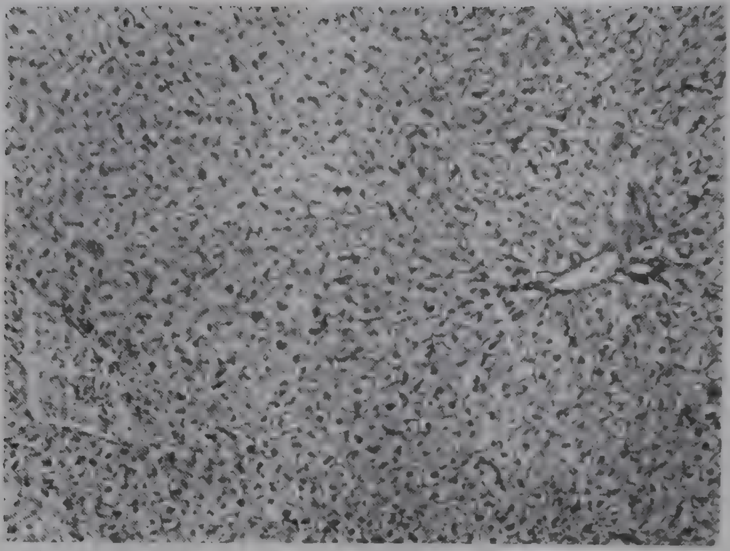

Fig. 1. Histological section of a rat maintained on maize-tapioca diet shows periportal fatty infiltration with severe cytoplasmic vacuolation. Hematoxylin and Eosin × 100.

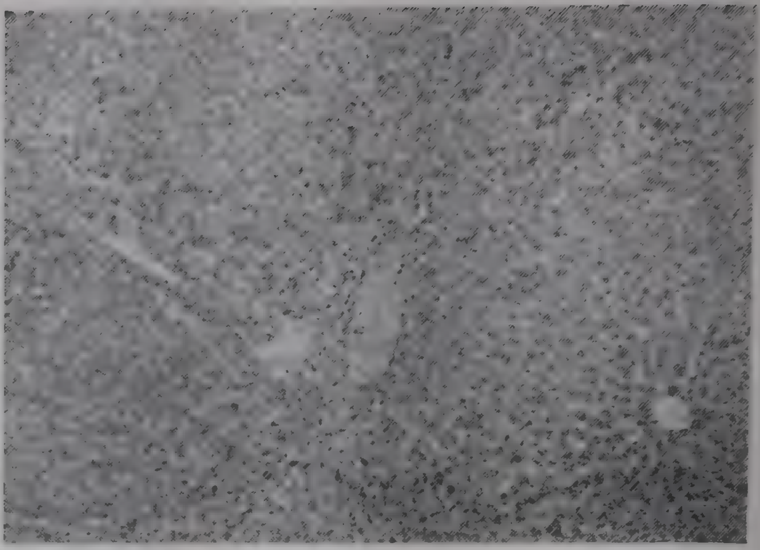

Fig. 2. Frozen section of another rat maintained on maize-tapioca diet, stained with Sudan IV shows the intensity of the fatty change around periportal area. Sudan IV × 100.

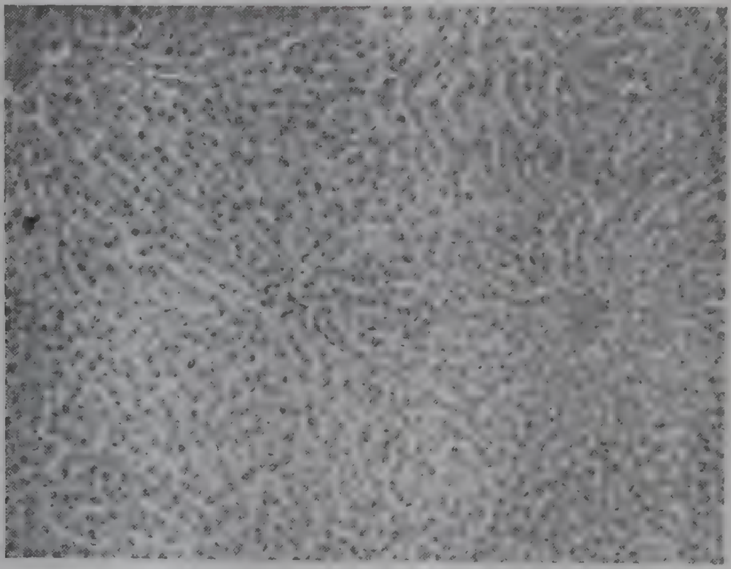

Fig. 3. Histological section of a liver of a rat maintained on maize-tapioca diet supplemented with fish flour shows normal histological picture. Haematoxylin and Eosin × 100.

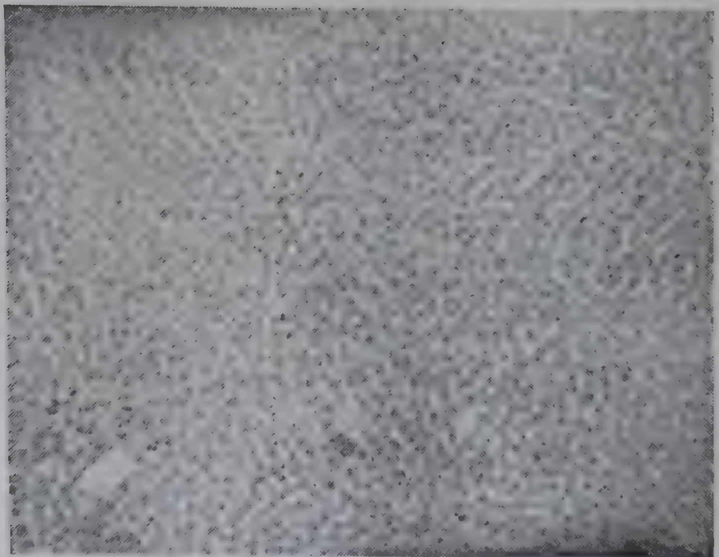

Fig. 4. Histological section of a liver of a rat maintained on maize-tapioca diet supplemented with protein food containing fish flour shows normal histological picture. Hematoxylin and Eosin × 100.

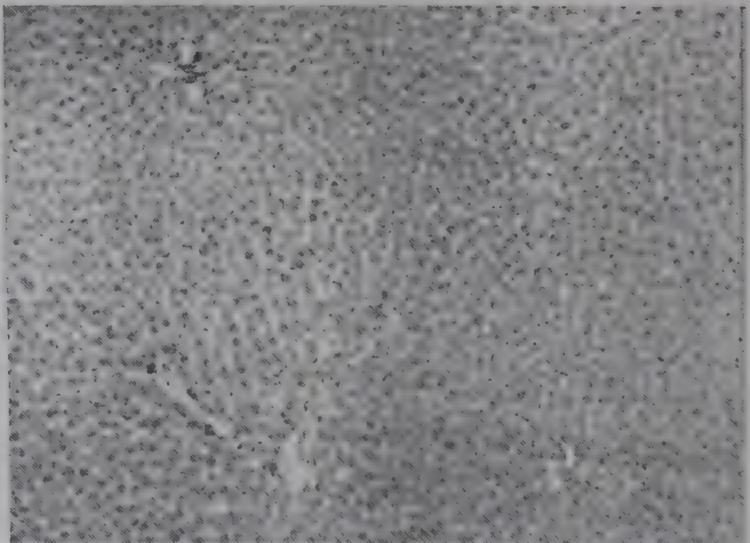

Fig. 5. Histological section of a liver of a rat maintained on maize-tapioca diet supplemented with skim milk powder shows normal histological picture. Hematoxylin and Eosin × 100.

TABLE III. *Chemical composition of livers and carcasses of rats fed on maize-tapioca diet supplemented with different protein foods*
(Period of experiment: 8 weeks; mean values for 6 males in each group)

Group	Diet	Average body weight (g)		Weight of fresh liver (g)	Liver						Carcass					
		Initial	Final		Moisture %		Fat %		Protein %		Moisture %		Fat %		Protein %	
A	Maize-tapioca—Control	48.2	62.2	2.49	69.50	±0.37 (15 d.f.)	5.02	±0.13 (15 d.f.)	14.97	±0.34 (15 d.f.)	65.49	±0.82 (15 d.f.)	12.94	±0.45 (15 d.f.)	14.33	±0.34 (15 d.f.)
B	Control+fish flour ...	47.8	240.3	8.38	71.31		3.36		18.62		55.52		20.35		17.53	
C	Control + protein food containing fish flour ...	48.2	238.2	8.13	70.69		3.47		18.23		55.13		21.31		17.30	
D	Control + skim milk powder ...	48.2	232.0	7.57	69.85		3.51		19.14		56.73		21.13		17.60	
	Critical difference at	5% level			1.11		0.38		1.02		2.45		1.35		1·03	
	,, ,,	1% ,,			1.54		0,52		1·41		3.39		1.87		1.42	
	,, ,,	0.1% ,,			2.13		0.72		1.95		4.69		2.58		1.96	

TABLE IV. *Intake and retention of protein in rats fed on maize-tapioca diet supplemented with different protein foods*
(Experimental period: 8 weeks; mean values for 6 males in each group)

Group	Diet	Total protein intake (g)	Total increase in body weight (g)	Initial body protein (g)	Total body protein (g)	Protein retained (g)	Protein retained per 100 g. increase in body weight*	
A	Maize-tapioca—Control	20.8	14.0	8.72	9.22	0.50	3.57	
B	Control+fish flour ...	76.2	192.5	8.66	42.10	33.44	17.38	±0.24 (10 d.f.)
C	Control + protein food containing fish flour ...	81.6	190.2	8.72	41.29	32.57	17.10	
D	Control+skim milk powder ...	77.4	183.8	8.72	40.84	32.12	17.43	
	Critical difference at		5% level				0.75	
	,, ,,		1% ,,				1.07	
	,, ,,		0.1% ,,				1.55	

* Statistical analysis of protein retained per 100 g. increase in body weight was carried out by omitting the control group (maize-tapioca diet) as the value obtained for this group of rats was very low as compared with protein supplemented groups.

milk powder were quite normal indicating thereby that incorporation of 10 per cent extra protein from fish flour or the protein food containing fish flour was effective in correcting the deficiencies of protein and other dietary essentials.

Intake and retention of protein: Data regarding the intakes and retentions of proteins by the rats fed the different diets are presented in Table IV. The data show that the retention of protein in animals fed on the maize-tapioca diet was only 0.5 g. while the retentions of protein on the protein supplemented diets ranged from 32.1 to 33.4 g. over a period of 8 weeks. No significant differences were observed in the mean retentions of protein (17.1—17.4 g.) per 100 g.

increase in body weight of rats receiving the different protein foods.

Discussion

A diet based mainly on a 1:1 blend of maize and tapioca contained only about 5 per cent protein of low nutritive value and promoted very little growth in rats. Supplementation of the diet with 10 per cent extra protein from fish flour or a protein food based on 2:1:1 blend of low fat groundnut flour, Bengalgram flour and fish flour made up the deficiency of proteins in the diet and promoted good growth in rats. At the level of 10 per cent extra protein, there were no significant differences in the mean growth of rats receiving the supplement of protein food or fish flour and skim milk powder. The results indicate that a protein food based on 2:1:1 blend of low fat groundnut flour, Bengalgram flour and fish flour could be used with advantage as a supplement to the diets of children in regions where milk and other protective food are in short supply.

Summary

1. A diet based on 1:1 blend of maize and tapioca contained only about 5 per cent protein and promoted very little growth (1.8 g./week) in albino rats. Supplementation of the diet with fish flour, a protein food based on 2:1:1 blend of groundnut flour, Bengalgram flour and fish flour or skim milk powder to provide 10 per cent extra protein in the diet, resulted in a highly significant ($P<0.001$) increase in the growth of rats. There were no significant differences in the mean weekly growth rates (19.3—19.7 g./week) on the different protein supplemented diets.

2. The mean fat content of the livers of rats fed on the maize-tapioca diet was significantly higher ($P<0.001$) and protein content significantly lower ($P<0.001$) than those of rats receiving the protein supplements.

3. The livers of rats fed on the control maize-tapioca diet showed moderate degree of parenchymal damage of the protein deficiency type and severe periportal fatty infiltration. On the other hand, the livers of animals receiving the different protein foods were quite normal indicating that when providing 10 per cent extra protein to the diet, the protein food consisting of 2:1:1 blend of groundnut flour, Bengalgram flour and fish flour was as effective as fish flour or skim milk powder in correcting the protein deficiency in the diet.

4. No significant differences were observed in the mean retentions of protein (17.1—17.4 g.) per 100 g. increase in body weight of rats receiving the different protein foods.

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RELATIVE VALUE OF A PROTEIN FOOD CONTAINING FISH FLOUR, GROUNDNUT FLOUR AND BENGALGRAM FLOUR AS COMPARED WITH SKIM MILK POWDER IN MEETING THE PROTEIN REQUIREMENTS OF PROTEIN DEPLETED RATS

By S. R. Shurpalekar, A. A. Joseph, N. L. Lahiry, M. N. Moorjani, M. Swaminathan,
N. Nataraja, A. Sreenivasan and V. Subrahmanyan

(*Central Food Technological Research Institute, Mysore*)

During recent years, several workers have used successfully a mixture of proteins of vegetable origin for the treatment of protein malnutrition in children[1-5]. The results so far reported indicate that while vegetable proteins are quite effective in curing the clinical signs and symptoms of protein malnutrition, the rate of regeneration of serum proteins in children treated with vegetable proteins is somewhat lower than that observed in cases treated with skim milk powder[2, 5]. This may be due to the fact that vegetable proteins do not provide adequate amounts of certain essential amino acids *viz.*, lysine and methionine, as compared with milk proteins for the rapid regeneration of serum proteins[6, 7]. Dean[8] reported that the rate of regeneration of serum proteins in children treated with a blend of groundnut flour and skim milk powder was nearly of the same order as that observed with children treated with skim milk powder. In earlier papers from this laboratory, it was reported that a protein food based on a 2:1:1 blend of groundnut flour, Bengalgram flour and fish flour possessed a high protein efficiency ratio and was highly effective as a supplement to a low protein diet based on maize and tapioca[9, 10]. The present paper relates to studies on the relative value of the protein food as compared with skim milk powder in meeting the protein requirements of protein depleted rats.

Experimental

Materials: The samples of protein food containing fish flour and skim milk powder used in this experiment were the same as those described in an earlier paper[9].

Animal experiments: Male albino rats (weighing about 100-110 g) from the laboratory stock colony were grouped according to randomized block design, ignoring litters, into 4 groups of 6 rats each. The animals were housed in individual cages with raised screen-bottoms. The initial values for haemoglobin, R.B.C. count, serum proteins, xanthine oxidase activity of liver and the moisture, fat and nitrogen contents of the livers and carcasses were determined in one group according to the methods cited below[11-13]. The remaining three groups were fed on a nitrogen-free diet (Table I) for a period of 25 days. The animals lost weight and attained a body weight of about 60-65 g. at the end of the period. The haemoglobin and red blood cell count were determined in the blood drawn from the tail of one group of depleted animals according to the methods used by Shurpalekar *et al*[11]. The animals of the same group were anaesthetised with ethyl ether. Blood was drawn by heart puncture

Table I. *Percentage composition of experimental diets*

Ingredients	I	II	III
	N-free diet	Protein food*	Skim milk powder†
Protein food containing fish flour ...	...	39.2	...
Skim milk powder ...	...	...	55.5
Corn starch ...	86.0	46.8	30·5
Groundnut oil ...	10.0	10.0	10.0
Salt mixture... ...	2·0	2.0	2·0
Vitaminised starch† ...	1.0	1.0	1.0
Shark liver oil ...	1.0	1.0	1·0

* The protein content of diets I and II on dry basis was about 20%.

† Composition of vitaminised starch was the same as that used by Shurpalekar *et al*[17].

and serum separated. The total serum protein content was determined according to King and Wooton[12]. The electrophoretic pattern of serum proteins was studied by the method of Durram[13]. The animals were then sacrificed and the moisture, fat and nitrogen contents of the livers and carcasses were determined according to the methods used by Shurpalekar *et al*[11]. The xanthine oxidase activity of the livers was determined according to Dhungat and Sreenivasan[14].

The remaining 2 groups were rehabilitated on diets (Table I) containing 20 per cent protein from protein food and skim milk powder respectively for a period of 21 days. Records of the body weight and food intake of individual rats were maintained. At the end of the period, the haemoglobin, R.B.C. count and serum protein contents were determined. The animals were then sacrificed. The xanthine oxidase activity of the liver and the moisture, fat and nitrogen contents of the livers and carcasses of rats were determined. From the results obtained, the retentions of nitrogen in the two groups of animals during the rehabilitation period were calculated. The results are given in Tables II-V.

Results

Effect of protein depletion on body weight and composition of blood, liver and carcass. Table III shows that rats depleted of protein for a period of 25 days by feeding on a protein-free diet lost on the average about 40 per cent of their body weight and 50 per cent of liver weight. The mean loss of total nitrogen of liver was about 55 per cent and that of the body was about 42 per cent. Table IV shows that there was a significant reduction in the serum protein and haemoglobin and red blood cell count of the blood. The

TABLE II. *Composition of liver and carcass of rats depleted[1] on N-free diet and after rehabilitation[2] on diets containing protein food or skim milk powder*

(Mean values for 6 males per group; level of protein in the diet: 20%)

Diet	Initial body weight (g)	Final body weight (g)	Liver					Carcass			
			Fresh weight (g)	Moisture %	Fat %	Protein %	Xanthine oxidase activity μO_2/g/hr.	Moisture %	Fat %	Protein %	Protein (on fat free basis)%
A. Initial-control (before depletion) ...	108.3	...	4.6	71.1	3.5	19.0	516.3	68.0	7.7	19.1	20.7
B. N-free diet (after depletion)	63.8	...	2.3	73.9	2.0	17.1	nil	66.8	6.4	18.7	20.0
C. Protein food (after rehabilitation) ...	63.8	141.3	5.6	70.9	3.0	20.7	521.5	61.2	14.0	18.3	21.3
D. Skim milk powder (after rehabilitation)	63.8	134.3	5·6	69.9	2.9	21.5	538.6	61.3	13.3	18.4	21·3

Mean difference (c.f. Table II) with its standard error based on 5 d.f. for:

Diets	Liver				Carcass			
	Moisture	Fat	Protein	Xanthine oxidase activity	Moisture	Fat	Protein	Protein (on fat-free basis)
B − A	2.82±0.30‡	−1.45±0.17‡	−1.89±0.40†		1.18±0·53*	1.33±0.80	0.34±0.31	...
C − B	−2.97±0.31‡	0·95±0.22†	3.55±0.73†		−5.67±0.42‡	7.61±0 53‡	−0.44±0.42	1.26±0·41*
D − B	−3.99±0 34‡	0.82±0.18†	4.33±0.40‡		−5·50±0 66‡	6.98±0.80‡	−0·31±0.31	1.26±0.32[1]
C ∼ D	1·02±0.38*	0.13±0.21	0.78±0.73	17.1±18.0	0·17±0.42	0.63±0.46	0·13±0.24	0.00±0.27

[1] Period of depletion 25 days.

[2] Period of rehabilitation 21 days.

‡ = very highly significant ($P < 0.001$) † = highly significant ($P < 0.01$) * = significant ($P < 0.05$).

TABLE III. *Loss or gain in weight and nitrogen content of body and liver of rats depleted on N-free diet and after rehabilitation on diets containing protein food or skim milk powder*
(Mean values for 6 males in each group)

Group	Diet		Body weight (g)	Total N in body (including liver) (mg)	Weight of liver (fresh) (g)	Total N in liver (mg)
	Original	Rehabilitation				
A	Stock diet (Initial-Control)	...	108.3	3,305	4.6	140
B	N-free diet[1]	...	63.8	1,908	2.3	63
			Loss (A-B) 44.5	1,397	2.3	77
C	N-free diet[1]	Protein food[2]	141.3	4,159	5.6	185
			Gain (C-B) 77.5	2,251	3.3	122
D	N-free diet[1]	Skim milk[2] powder	134.3	3,987	5.6	192
			Gain (D-B) 70.5	2,079	3.3	129

[1] Depleted of body protein by feeding on N-free diet for 25 days.

[2] Rehabilitated by feeding on the diets containing 20% protein from the protein food or skim milk powder for 21 days.

TABLE IV. *Composition of blood of rats depleted[1] on nitrogen—free diet and after rehabilitation[2] on diets containing protein food or skim milk powder as compared with that of control animals*
(Mean values for 6 males per group; level of protein in the diet: 20%)

Group	Diet	Red blood cell count (10^6/c.mm)	Haemoglobin (g/100 ml.)	Total serum protein (%)	Electrophoretic serum protein pattern				
					Albumin %	Alpha-1 globulin (%)	Alpha-2 globulin (%)	Beta-globulin (%)	Gamma globulin (%)
A	Initial-control (before depletion) ...	7.79	16.08	6.21	34.8	20.0	9.3	24.0	12.1
B	N-free diet ...	5.95	13.33	4.55	23.5	18.0	19.6	18.1	20.7
C	Protein food ...	7.98	16.17	6.05	34.5	19.0	9.9	22.8	12.8
D	Skim milk powder ...	7.83	15.96	6.17	35.1	21.1	8.9	24.3	11.8
	Mean difference with its standard error (based on 5 d.f.)								
	B−A	-1.84 ± 0.25^{3}	-2.75 ± 0.32^{3}	-1.66 ± 0.13^{3}	-11.28 ± 0.99^{3}	-1.93 ± 1.20	10.39 ± 0.37^{3}	-5.82 ± 0.79^{3}	8.66 ± 0.99^{3}
	C−B	2.03 ± 0.28^{3}	2.84 ± 0.32^{3}	1.50 ± 0.14^{3}	10.95 ± 1.27^{3}	1.01 ± 0.57	-9.79 ± 0.61^{3}	4.71 ± 0.75^{4}	-7.90 ± 1.08^{3}
	D−B	1.88 ± 0.19^{3}	2.63 ± 0.21^{3}	1.62 ± 0.14^{3}	11.57 ± 1.78^{4}	3.03 ± 0.77^{4}	-10.77 ± 0.42^{4}	6.14 ± 1.41^{4}	-8.98 ± 0.45^{3}
	C∼D	0.15 ± 0.34	0.21 ± 0.27	0.12 ± 0.26	0.62 ± 1.94	2.02 ± 0.88	0.98 ± 0.60	1.43 ± 1.73	1.08 ± 0.86

[1] Period of depletion 25 days. [2] Period of rehabilitation 21 days. [3] = very highly significant ($P < 0.001$). [4] = highly significant ($P < 0.01$). [5] = significant ($P < 0.05$)

results given in Table II show that the xanthine oxidase activity was completely lost in the livers of protein depleted animals.

Effect of rehabilitation with diets containing the protein foods on body weight and the composition of blood, liver and carcass. Tables II and V show that depleted rats when fed on diets containing 20 per cent protein rapidly gained in body weight. The mean gains in body weight per gram of protein intake were 1.94 and 2.08 respectively on diets containing the protein food and skim milk powder. The mean gains in body weight per gram of protein retained were 6.05 and 6.15 while the mean protein retentions per 100 g. increase in body weight were 16.63 and 16.42 per cent respectively on the two diets, indicating thereby that the increase in body weight was followed by a corresponding increase in body protein. The mean protein retentions expressed as percentage of the intakes were 32.06 per cent

TABLE V. *Intake and retention of protein in protein depleted rats after rehabilitation*[1] *on diets containing protein food or skim milk powder*

(Mean values for 6 males in each group; level of protein in the diet: 20%)

Diet	Protein intake (g)	Gain in body weight (g)	Gain in body weight per g. of protein intake (3 weeks)	Initial body protein* (g)	Total body protein (g)	Protein retained (g)	Gain in weight per g. protein retained (g)	Protein retained as % of intake	Protein retained per 100g. gain in body weight (g)
C. Protein food containing fish flour ...	40.6	77.5	1.94	12.0	24.9	12.9	6.1	32.1	16.6
D. Skim milk powder ...	34.0	70.5	2.08	12.0	23.6	11.6	6.2	33.9	16.4
Mean difference with its standard error (based on 5 d.f.) C~D		7.0± 3.9	0.14± 0.13				0.10± 0.22	1.86± 1.65	0.21± 0.60

*Calculated from the protein content of the carcass of rats depleted on N-free diet for 25 days (c.f. Table II).

[1] Period of rehabilitation 21 days.

and 33.92 respectively on the two diets. There were no significant differences in the mean moisture, fat and protein contents of the livers and carcasses of rats rehabilitated on diets containing protein food or skim milk powder.

The mean xanthine oxidase activity of the livers of depleted rats were restored to normal levels by feeding for 3 weeks on diets containing 20 per cent protein from protein food and skim milk powder. The mean serum protein, haemoglobin and red blood cell count of rats were also restored to normal levels as a result of rehabilitation on diets containing 20 per cent protein, there being no significant differences in the response of rats on the diets containing protein food or skim milk powder.

Discussion

The results indicate that a protein food based on 2:1:1 blend of low fat groundnut flour, Bengalgram flour and fish flour is as effective as skim milk powder in meeting the protein requirements of protein depleted animals, when the level of protein in the diets was 20 per cent. This finding is of considerable practical importance when viewed in the light of acute shortage of milk and other animal proteins and the high incidence of protein malnutrition amongst children belonging to the low income groups of the population in several countries in the tropical and sub-tropical regions[15]. There is considerable scope for the production of fish flour and for using it in combination with protein rich foods of vegetable origin as supplements to the diets of children and other vulnerable sections of the population in these regions[16].

Summary

1. Male albino rats weighing about 100-110 g., when fed on a nitrogen-free synthetic diet for a period of 25 days, lost on an average about 40 per cent of body weight, 42 per cent of total body nitrogen, 50 per cent of liver weight and 55 per cent of total liver nitrogen. The xanthine oxidase activity of liver was completely lost. There was a significant reduction in the total serum proteins, haemoglobin and red blood cell count of the blood.

2. When the protein depleted animals were rehabilitated by feeding for 21 days on diets containing 20 per cent protein from a protein food based on 2:1:1 blend of low fat groundnut flour, Bengalgram flour and fish flour or skim milk powder, the serum protein levels and haemoglobin and red blood cell counts were restored to normal levels. The xanthine oxidase activity of the liver was also restored to normal level.

3. The mean gains in body weights per gram of protein intake were 1.94 and 2.08 and the mean gains in body weight per gram of protein retained were 6.05 and 6.15 respectively. The mean protein retentions per 100 g. increase in body weight were 16.63 g. and 16.42 g. respectively. The mean protein retentions expressed as percentage of the intakes were 32.06 and 33.92 respectively on the two diets. No significant differences were observed in any of the above constituents between the two groups of rats fed on diets containing protein food or skim milk powder.

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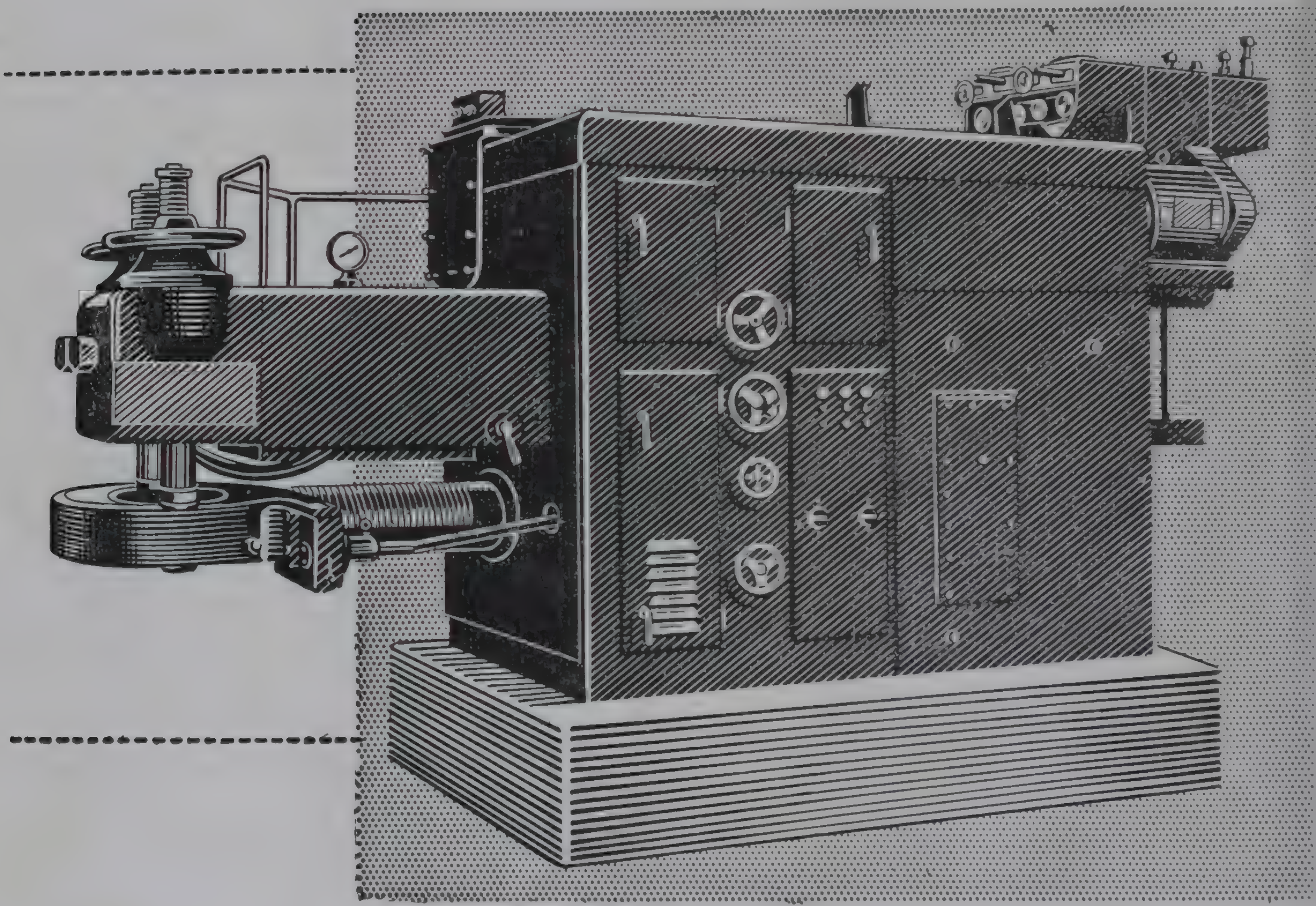

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STUDIES ON DEHYDRATION OF SOME TROPICAL FRUITS—PART I. ABSORPTION AND RETENTION OF SULPHUR DIOXIDE DURING SULPHURING AND SULPHITING

By B. S. Bhatia, H. D. Amin* and Girdhari Lal†

(Central Food Technological Research Institute, Mysore)

The presence of sulphur dioxide in the dried fruit is essential to prevent deterioration in its natural colour, flavour and palatability for reasonably long periods during storage and also to protect some nutrients like ascorbic acid, etc. For this, it is necessary to standardise conditions among others for pre-treatment whereby enough SO_2 is taken up by the fruit before it goes into the drier so that there is reasonable retention even after losses during drying.

With the object of obtaining information on various aspects of sulphuring and sulphiting of tropical fruits like banana, pineapple, papaya and mango, an investigation was carried out to study the effect of factors like variety, maturity, size, thickness, method of drying (dehydration or sundrying) blanching etc., on the sulphur dioxide absorption and retention by these fruits. The results are briefly described in this paper.

Materials and Methods

Pachabale, *Chandrabale*, *Kadabale*, *Salem* and *Nanjangud Rasabale* varieties of ripe banana; *Giant Kew* variety of pineapple; *local Mysore* variety of ripe papaya and *Raspuri* and *Badami* varieties of mangoes were used. In the case of *Pachabale* variety of bananas, fruits of three different degrees of maturity *viz.*, slightly over-mature, mature and slightly under-mature, were studied.

Bananas were peeled by hand and the whole peeled fruits or slices were used for drying. Pineapples were washed and sliced with a pineapple slicing machine. Their skin and core were removed by punching and coring knives, and segments of suitable size and thickness were prepared. Firm ripe papayas were washed, peeled with stainless steel knives, cut into quarters, the seeds removed, and pieces of suitable size obtained. Mangoes were washed, peeled with stainless steel knives and cut into suitable size pieces or slices.

Sulphuring was done in a wooden sulphur box ($2\frac{3}{4}' \times 2\frac{3}{4}' \times 2'$) provided with a vent hole at the top and a glass window on the side. The fruit was spread on wooden slat-bottom-trays loading 3-4 lb. per sq. ft. of tray area and exposed to fumes of sulphur for the required length of time. To ensure uniform concentration of sulphur dioxide in the chamber, known quantities of sulphur were added to the burning pot after every half an hour.

Sulphiting was done, in a few cases, by steeping the fruits in a known concentration of potassium metabisulphite (KMS) solution for a definite period.

Steam blanching was done by exposing the fruits spread on wiremesh trays, to live steam at atmospheric pressure in an autoclave.

Dehydration was carried in a cross-flow electric cabinet drier using aluminium trays or in a through-flow drier using 14 mesh trays. For comparison, sun-drying was also done in some cases, using aluminium trays.

Moisture was estimated by drying the finely chopped fruit pieces spread on flat aluminium dishes in a drying oven at 70°C for 72 hours. The values thus obtained were comparable with those obtained by vacuum drying method. Total sulphur dioxide was determined by the modified Monier William method[1] using iodine, the distillation time being 45 minutes.

Results and Discussion

1. BANANA

(*i*) *Sulphiting vs sulphuring :* In order to study the absorption (after sulphiting or sulphuring) and retention (after drying) of SO_2, comparison of sulphiting and sulphuring whole fruit and

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* Student of Fruit Technology Associateship Course (1958-60) and now Lecturer at the Agricultural College, Junagadh.

† Assistant Director, Fruit Technology Division (since retired).

TABLE I. *Effect of sulphiting and sulphuring on SO_2 content of dehydrated whole Pachabale banana*

Steeping time in 1% KMS solution (Hrs)	SO_2* p.p.m. Before drying	SO_2* p.p.m. After drying	Sulphuring @ 15 lb. sulphur per 1000 cu. ft. per 7 tons fruit (Time-hours)	SO_2* p.p.m Before drying	SO_2* p.p.m After drying
0.5	263	108	0.5	112	...
1.0	202	67	1.0	2613	382
2.0	119	67	2.0	5520	1240
3.0	154	130	3.0	8716	2689

* Moisture free basis.

TABLE II. *Effect of sulphiting and sulphuring on SO_2 content of Pachabale banana slices (½″ thick)*

Steeping time in 1% KMS solution (Hrs)	SO_2 absorption p.p.m.	Steeping time in 5% KMS solution (Hrs)	SO_2 absorption p.p.m.	Sulphuring @ 15 lb. sulphur/1000 cu.ft/7 ton fruit (Time-hrs)	SO_2 absorption p.p.m.
0.25	77	...	...	...	...
0.5	186	0.5	244	0.5	601
1.0	317	1.0	1182	1.0	872
1.5	1969	1.5	1328	1.5	946
2.0	2113	2.0	3031	2.0	1120
2.5	2644	2.5	3548	2.5	2100
3.0	4250	...	...	3.0	2120

half inch thick slices of *Pachabale* variety of banana was made and the results are given in Tables I and II, which show that even after a steeping period of 3 hours in 1 per cent KMS solution, whole bananas did not absorb enough SO_2, whereas absorption and retention of SO_2 was satisfactory after two hours of sulphuring. In the case of ½″ thick slices, absorption of SO_2 was not satisfactory after a steeping time of 3 hours in both 1 per cent and 5 per cent KMS solutions. However, the texture was adversely affected due to disintegration of slices thereby rendering them unsuitable for drying. Further, the steeping process caused considerable leaching out of nutrients, thus adversely affecting the flavour and nutritive value of the finished product. This observation is in agreement with that of Von Loescke[2] who could not get efficient absorption of SO_2 in banana slices by steeping in 3 per cent sulphurous acid solution.

(*ii*) *Effect of sulphuring time on absorption and retention of SO_2*: In Table III, retention ratios in the case of whole fruit (*Pachabale* variety of banana) after different periods of sulphuring are given. Expressed on fresh weight basis, the retention ratios are 3-4 times higher than the corresponding ratios expressed on moisture-free basis. In literature, the usual practice is to express these ratios on 'as such' basis which is useful from a practical point of view, although the interpretation of data can be better done if values on moisture-free basis are considered. This ratio in the case of banana is much higher than that reported[3] for apricots (less than 0.18) showing thereby that absorption and retention of SO_2 in banana is highly efficient.

TABLE III. *Effect of sulphuring time on absorption and retention of SO_2 in whole Pachabale banana and ½″ thick slices*

(Values in brackets are on moisture-free basis)

	Sulphuring time (hrs)	Absorption p.p.m.	Retention p.p.m.	Retention ratio
Whole fruit ...	1.0	674 (2613)	332 (382)	0.49 (0.14)
	1.5	1076 (4205)	570 (648)	0.53 (0.15)
	2.0	1402 (5520)	1026 (1240)	0.73 (0.22)
	2.5	1766 (7092)	1313 (1519)	0.74 (0.21)
	3.0	1848 (8716)	2178 (2689)	1.18 (0.31)
Slices (½″ thick) ...	2.0	1918 (6949)	2692 (3370)	1.40 (0.46)
	3.0	2249 (8592)	3643 (4951)	1.60 (0.58)

(*iii*) *Absorption and retention of SO_2 as affected by maturity in Pachabale banana:* Quinn[4], Jewell[5] and Mrak[6], working on apricots indicated that maturity is a critical factor in the successful sulphuring practice and observed that ripe fruits frequently absorbed less SO_2 than green fruits, but always had a much higher retention ratio. The results of the present study shown in Table IV are in line with these findings. The slightly over-mature fruits absorbed less SO_2, but the

TABLE IV. *Absorption and retention of SO_2 as affected by maturity in Pachabale banana*
(Values in brackets are on moisture-free basis)

Degree of maturity	Absorption p.p.m.	Retention p.p.m.	Retention ratio
Slightly over-mature ...	954 (3357)	1241 (1613)	1.30 (0.48)
Mature ...	966 (3711)	1325 (1778)	1.37 (0.48)

retention ratio for matured and slightly over-mature fruits were similar.

(*iv*) *Effect of size of Pachabale bananas on their absorption and retention of SO_2*: Mrak and Phaff[7], studying the effect of three different sizes of *Tilton* variety of apricot on their absorption and retention of SO_2, could not come to a definite conclusion. The data presented in Table V. indicate that the retention ratio expressed on moisture-free basis is higher in a bigger size fruit than in a small size one. The values in the case of medium and small size fruits, were more or less similar. However, there does not seem to be much difference in the retention ratios expressed on 'as such' basis.

TABLE V. *Effect of size of Pachabale bananas on their absorption and retention of SO_2*
(Values in brackets are on moisture-free basis)

Size of fruit	Absorption p.p.m.	Retention p.p.m.	Retention ratio
Big ...	951 (3282)	1105 (1629)	1.16 (0.50)
Medium ...	1282 (4647)	1355 (1706)	1.06 (0.37)
Small ..	1126 (4327)	1386 (1764)	1.23 (0.41)

(*v*) *Absorption and retention of SO_2 during sulphuring and dehydration* (*in a cabinet drier*) *and sun-drying of different varieties of banana:* The results presented in Table VI indicate that the SO_2 retention on moisture-free basis is the highest in *Kadabale* variety both during dehydration and sun-drying. The retention ratios in *Pachabale*, *Nanjangud Rasabale*, *Chandrabale* and *Salem* varieties are in the descending order during dehydration, while in *Chandrabale*, *Salem* and *Pachabale* varieties similar trend is seen during sun-drying.

(*vi*) *Effect of the position of tray in the sulphur-box on the SO_2 absorption of the fruit:* During sulphuring of bananas, absorption of SO_2 was 1654 and 1677 p.p.m. respectively in the top and the bottom trays. Expressed on moisture-free basis, the values were 6059 and 6425 p.p.m. respectively. This shows that there is slightly more absorption of SO_2 in the bottom tray than in the top tray.

(*vii*) *Retention of SO_2 of sulphured Pachabale banana fruit during different stages of drying:* Of the SO_2 absorbed by the fruit immediately after sulphuring, only a limited quantity remains at the end of drying. Hence it was of interest to study the SO_2 content during different stages of dehydration (cross-flow cabinet drier) and sun-drying (8 hours each day; R.H. 22-59 per cent and air temperature 34-39°C, between 2 and 2-30 p.m.). The results given in Table VII show that the greatest loss of SO_2 occurs during the first three hours of dehydration. This may be partly due to fast removal of the loosely held SO_2 from the surface of the fruits. Later on, heating of the fruit and drying of the fruit

TABLE VI. *Absorption and retention of SO_2 during sulphuring and drying of different varieties of bananas*
(Values in brackets are on moisture-free basis)

Variety	Dehydration			Sundrying		
	Absorption p.p.m.	Retention p.p.m.	Retention ratio	Absorption p.p.m.	Retention p.p.m.	Retention ratio
Salem ..	638 (2179)	593 (764)	0.93 (0.35)	638 (2179)	301 (445)	0.47 (0.20)
Kadabale ...	999 (3135)	1267 (1642)	1.27 (0.52)	999 (3135)	1370 (1910)	1.30 (0.60)
Chandrabale ...	1177 (4019)	1199 (1523)	1.02 (0.38)	1177 (4019)	1348 (2009)	1.14 (0.50)
Pachabale ...	966 (3711)	1325 (1778)	1.37 (0.48)	966 (3711)	422 (579)	0.44 (0.16)
Nanjangud Rasabale ...	481 (1541)	545 (661)	1.13 (0.43)	...	...	...

TABLE VII. *Retention of SO_2 by sulphured Pachabale banana fruit during different stages of dehydration (cross-flow cabinet drying and sun-drying)*

(Values in brackets are on moisture-free basis)

Dehydration			Sundrying		
Drying time (hrs)	Moisture %	Absorption (p.p.m.)	Drying time (hrs)	Moisture %	Absorption (p.p.m.)
0.0	73.30	1665 (6236)			
3.0	65.19	1198 (3442)	0.0	73.30	1665 (6236)
4.5	61.15	1438 (3701)	24.0	58.82	1915 (4650)
6.5	56.67	1874 (4324)	48.0	38.77	968 (1581)
14.5	49.29	1933 (3813)			
17.5	41.15	2009 (3416)	72.0	26.13	1226 (1600)
19.5	34.85	2472 (3793)			
22.0	31.00	2385 (3457)	96.0	15.96	1996 (2375)
24.0	26.99	2438 (3339)	120.0	13.17	(1752) (2018)

TABLE VIII. *Effect of initial blanching of banana followed by sulphuring and drying on SO_2 retention*

(Values in brackets are on moisture-free basis)

Treatment	Absorption p.p.m.	Retention p.p.m.	Retention ratio
(i) Steam blanched sulphured and dried ...	1039 (2800)	922 (1392)	0.89(0.49)
(ii) Sulphured and dried ...	966 (3711)	1325 (1778)	1.37(0.48)

surface apparently increase the fixation of SO_2 and make its escape more difficult. Trend of results during sun-drying is the same as during dehydration, except that the drying of the exposed surface is little slower and as such, during the first 48 hours, the loosely held SO_2 tends to leave the fruit comparatively at a faster rate. It appears that SO_2 content of the fruit after 48 hours of sun-drying will roughly be the same as in the final dried product. This observation is in line with the observation of Roleson and Nichols[8], Hicks[9] and Long *et al*[3] who found that the SO_2 content of apricots, after they had been in the drying yard for one day, would be similar to the retention when dried.

(*viii*) *Effect of initial blanching followed by sulphuring and drying on SO_2, retention in Pachabale banana*: The data for (*a*) the blanched, sulphured and dried fruits and (*b*) sulphured and dried fruits, are given in Table VIII which show that the retention ratio in both the cases on moisture-free basis is the same. Chace, Church and Sorber[10] conducting large-scale experiments on sulphuring of apricots made the same observation. However, in their case, when the fruits were blanched after sulphuring, the retention of SO_2 was 50 per cent higher. The product was attractive and translucent.

2. PINEAPPLE

Data in respect of the absorption and retention values of SO_2 in dehydrated pineapple slices, dried under different treatments are given in Table IX. Crowther *et al*[11] observed the SO_2 contents to vary widely from 461 to 1561 p.p.m., in spite of sulphuring ¾" thick slices for 2 hours. The data obtained in this investigation show that in order to get an optimum value of 2000 p.p.m. SO_2 in ¼" thick slices, sulphuring should be done at least for about 2 hours. The retention was comparatively better in ⅛" thick slices than in ¼" thick slices. Unlike apricots[3], the retention ratios here are higher which show that the SO_2 retention is efficient during drying.

As in the case of banana, the product when steam blanched and dried was attractive and translucent in appearance but resulted in less retention of SO_2. Retention of SO_2 is better when drying is done in a through-flow drier than when it is dried in a cabinet drier, perhaps due to less drying time.

A few trials done with sulphiting were not found to be helpful in the efficient retention of SO_2 and hence given up.

3. PAPAYA

In preliminary trials using ⅛", ¼" and ½" thick papaya slices followed by sulphuring for 30 minutes (using 15 lb. of powdered sulphur/1000 c.ft/7 tons fruit), the retention values of SO_2 were 705, 793 and 394 p.p.m. respectively, which were considered too low. In a later experiment

TABLE IX. *Absorption and retention of SO_2 in pineapple dehydrated after different treatments*
(Values in brackets are on moisture-free basis)

Material	Treatment	Absorption p.p.m.	Retention p.p.m.	Retention ratio
⅛″ thick slices	Sulphured for 30 mins. @ 15 lbs. sulphur per 1,000 cu. ft. per 7 tons of fruit	482 (3127)	473 (511)	0.98 (0.16)
¼″ ,, ,,		464 (2493)	291 (322)	0.63 (0.09)
½″ ,, ,,		261 (2096)	368 (503)	1.40 (0.24)
¼″ thick slices (steam blanched)	Sulphured for 2 hours @ 15 lb. sulphur per 1,000 cu. ft. per 7 tons of fruit	342 (1576)	538 (682)	1.60 (0.43)
¼″ thick slices (dried in a cabinet drier)		1803 (17240)	1863 (2327)	1.03 (0.13)
¼″ thick slices (dried in through-flow drier)		1803 (17240)	3022 (3845)	1.70 (0.22)
¼″ thick slices	Steeped in 0.25% KMS soln. for 30 mins.	203 (1756)	261 (292)	1.30 (0.17)

TABLE X. *Absorption and retention of SO_2 in 1″ thick papaya slices sulphured for 2 hrs. @ 15 lb. sulphur/1000 cu. ft. per 7 tons of fruit*
(Values in brackets are on moisture-free basis)

	Absorption p.p.m.	Retention p.p.m.	Retention ratio
1. Dehydrated	1765 (16810)	2323 (3442)	1.30 (0.20)
2. Sun-dried	1765 (16810)	2046 (3552)	1.16 (0.21)

TABLE XI. *Absorption and retention of SO_2 in Raspuri and Badami mangoes dried under different treatments*
(Values in brackets are on moisture-free basis)

	Absorption p.p.m.	Retention p.p.m.	Retention ratio
Raspuri			
1. Whole slices sun-dried	1500 (7895)	828 (973)	0.55 (0.12)
2. Whole slices dehydrated	1500 (7895)	1762 (2320)	1.17 (0.29)
3. 1–1¼″ × 1″ slices dehydrated	1500 (7895)	2624 (2873)	1.70 (0.36)
Badami			
1. Steam blanched and dried	1029 (3463)	282 (425)	0.27 (0.12)
2. Ordinarily dried	1350 (8084)	742 (1033)	0.55 (0.22)

carried out with 1″ thick slices, sulphured for 2 hours, results (Table X) showed that the retention of SO_2 was about 2000 p.p.m. both in dehydrated and sun-dried samples. As in the case of banana and pineapple, the retention of SO_2 is quite efficient and is much better than reported for apricots[3].

Although fairly good retention of SO_2 could be obtained by steeping for 1/2 hour in 1 per cent KMS solution, the texture of the fruit was adversely affected and this was, therefore, not considered a desirable treatment.

4. MANGO

The results obtained for the absorption and retention values of SO_2 in *Raspuri* and *Badami* varieties of mango are given in Table XI. These indicate that the retention of SO_2 in 1¼″ × 1″ *Raspuri* mango slices dehydrated in a through-flow drier was better than in the sun-dried samples. Retention was slightly less in the case of bigger slices than with 1″×1¼″ thick slices. Blanching resulted in lowering the retention value.

Summary

An investigation on the absorption and retention of SO_2 during the dehydration of some tropical fruits has shown that (*i*) absorption and retention of SO_2 is satisfactory in the case of *Pachabale* whole banana, ½″ thick banana, ¼″ thick pineapple, 1″ thick papaya and 1-1¼″

thick mango slices when sulphured for two hours in a sulphurbox, burning sulphur @ 15 lb./1000 c. ft./7 tons fruit. (*ii*) Sulphiting of fruit slices by steeping in 0.25-5.0 per cent KMS solution for 30 minutes is not a desirable treatment, being ineffective in giving the desired SO_2 retention besides adversely affecting the texture of fruits. (*iii*) Retention of SO_2 is less if fruit is blanched before sulphuring. (*iv*) Absorption of SO_2 is lower in slightly over-mature bananas when compared with mature fruits; retention of SO_2, is, however, similar in both cases. (*v*) Expressed on moisture-free basis, the retention ratio is higher in bigger size banana fruits than in small and medium size fruits. (*vi*) Both during dehydration and sun-drying, the SO_2 retention on moisture-free basis is the highest in *Kadbale* variety of banana. The value goes down in descending order in the case of *Pachabale*, *Nanjangud Rasabale*, *Chandrabale* and *Salem* varieties, during dehydration. During sun-drying, the retention value is in decreasing order in the case of *Chandrabale*, *Salem* and *Pachabale*. (*vii*) Loss of SO_2 in banana during the first 3 hours of dehydration is the highest. It appears that SO_2 content of the fruit after 48 hours of sun-drying or 3 hours of dehydration is the same as in the final dried product.

Acknowledgment

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STUDIES ON DEHYDRATION OF SOME TROPICAL FRUITS—PART II: DRYING RATES AS AFFECTED BY VARIOUS FACTORS

By H. D. AMIN* AND B. S. BHATIA

(Central Food Technological Research Institute, Mysore)

The time required for drying any commodity depends upon the amount of moisture to be removed from it and the rate of its removal. The less the time, the more it helps in providing conditions which are favourable for rapid and economical drying. Several factors like the type of drier, nature of fruit, its variety, maturity, thickness of pieces etc., affect the drying rate. These have been studied in the case of banana, pineapple, papaya and mango.

Experimental

The materials and methods employed during this investigation were the same as described in the earlier paper[1]. The results obtained are discussed below.

1. BANANA

(*i*) *Type of driers:* The relative suitability of the two types of driers, cross-flow cabinet drier and through-flow drier, has been compared. Using the comparable conditions of tray-loading (2.5—3.0 lb/sq. ft.), the drying curves of the dehydrated whole fruit (*Pachabale* banana) are shown in Fig. 1. The air temperature in the case of cross-flow drier was 85-86°C, for the first 3 hours, 76°C for the next 3½ hours and 60°C thereafter. The air velocity was 4-6 ft. per

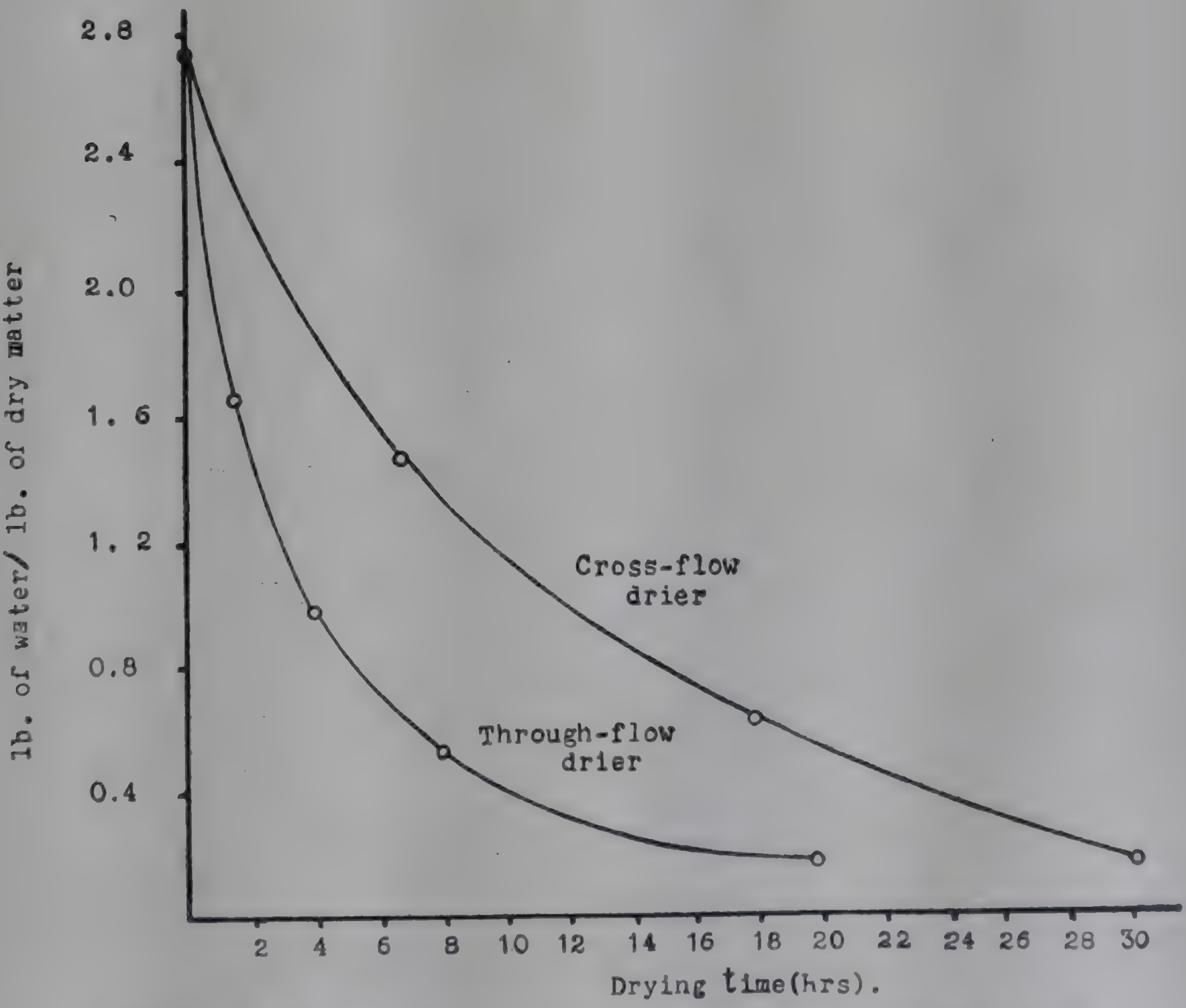

FIG. 1 a. Drying curves of *Pachabale* banana in cross-flow and through-flow driers.

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* Student of Fruit Technology Associateship Course (1958-60) and now Lecturer at the Agricultural College, Junagadh.

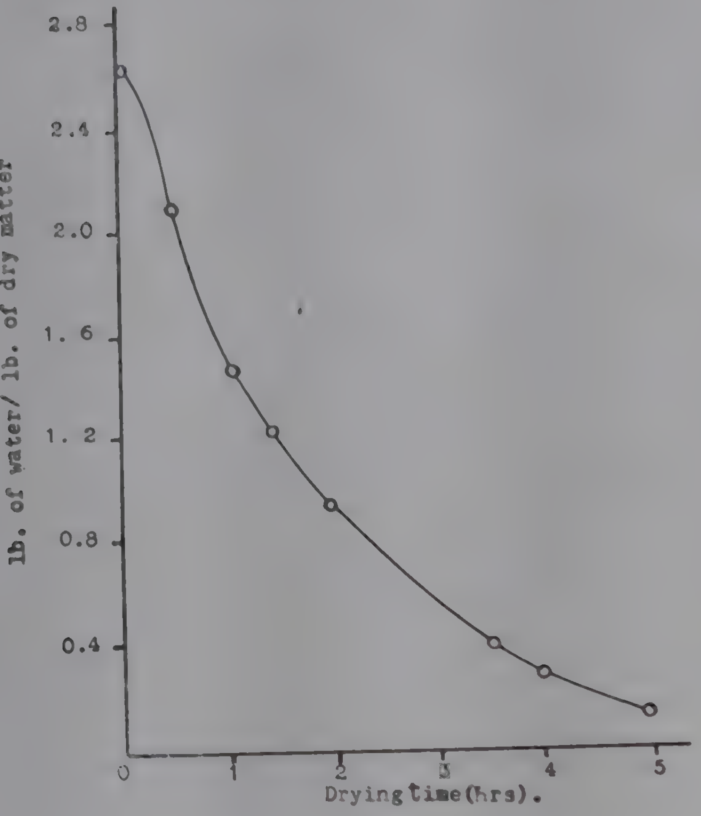

FIG. 1 b. Drying curve of *Pachabale* banana slices (⅛″ thick) in through-flow drier.

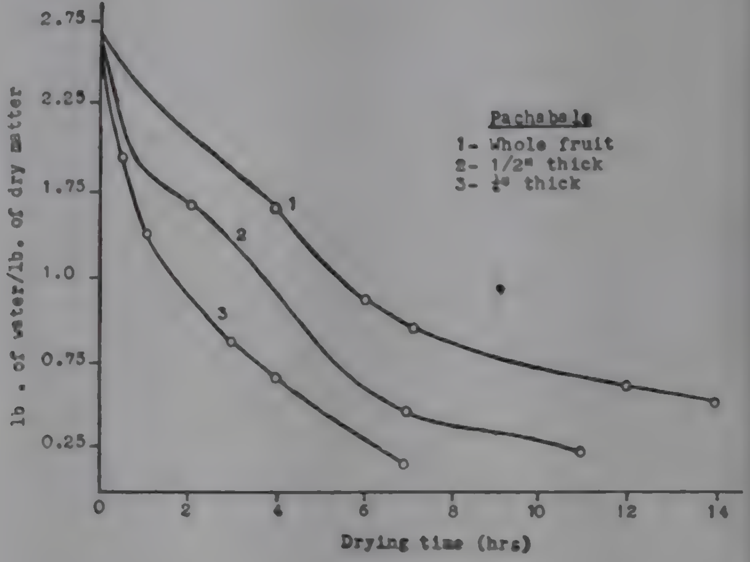

FIG. 2. Drying rates in whole fruit and in slices of different thickness in two varieties of banana.

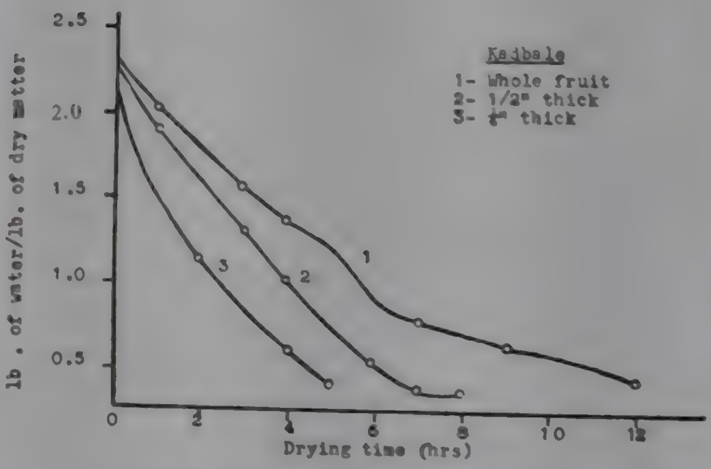

FIG. 3. Drying rates in whole fruit and slices of different thickness in two varieties of banana.

second in the case of cross-flow and 3-4 ft. per second in the through-flow drier. Under these conditions, drying was much more efficient in the case of through-flow drier, taking about 20 hours to reach the same moisture level, as compared to 30 hours in the case of cross-flow drier. Organoleptic quality was superior in the product obtained with a through-flow drier.

(*ii*) *Effect of thickness of fruit:* With a cross-flow cabinet drier, drying curves obtained in the case of whole fruit, ½″ and ¼″ thick slices of *Pachabale* and *Kadable* bananas are given in Figs. 2 and 3, which show that the drying rates are faster in thinner pieces, in both the varieties. In the case of ¼″ thick slices, for a moisture ratio of 0.4, drying time is as low as 6 hours in *Pachabale* and 4 hours in *Kadabale* whereas for the whole bananas, these periods are 15 and 12 hours respectively. This reduction of drying time increases the capacity of a dehydrator substantially. The drying of the pieces is more uniform and the uniform penetration of SO_2 prevents them from rapid discolouration. The pieces are attractive in appearance both in the dry condition and after cooking. They also reconstitute quickly and uniformly.

In the case of *Kadabale* whole banana the drying is faster because it has a comparatively smaller diameter than *Pachabale* banana. The drying rates in the case of different sizes (9″, 7″ and 5″ in large, medium and small bananas respectively) of whole *Pachabale* banana (Fig. 4) show that the rate of drying is faster in the initial stages of drying in the case of small size fruits but there is not much difference in the total drying time for the three sizes.

(*iii*). *Effect of maturity:* The drying curves of *Pachabale* banana of different maturities obtained by drying in a cross-flow drier are given in Fig. 5. The slightly over-mature fruits dry at a slower

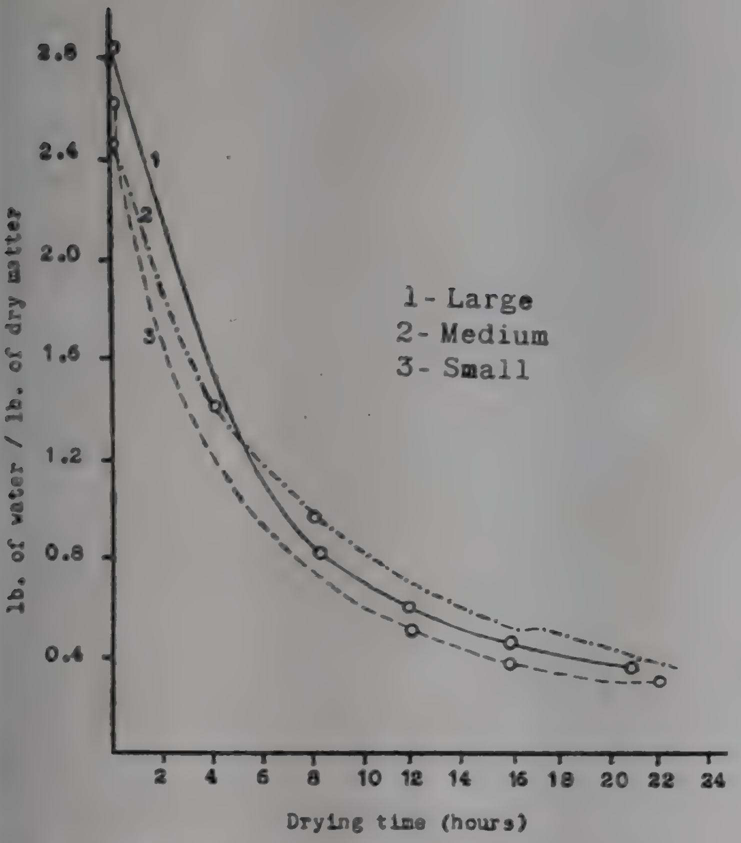

FIG. 4. Drying rates of *Pachabale* banana of different sizes.

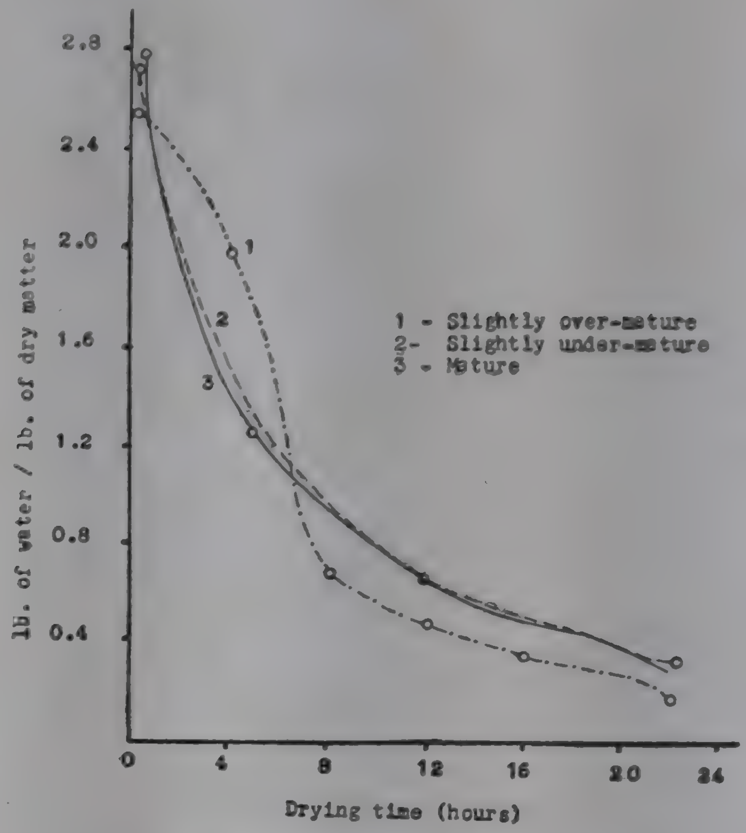

FIG. 5. Drying rates of *Pachabale* banana of different maturities.

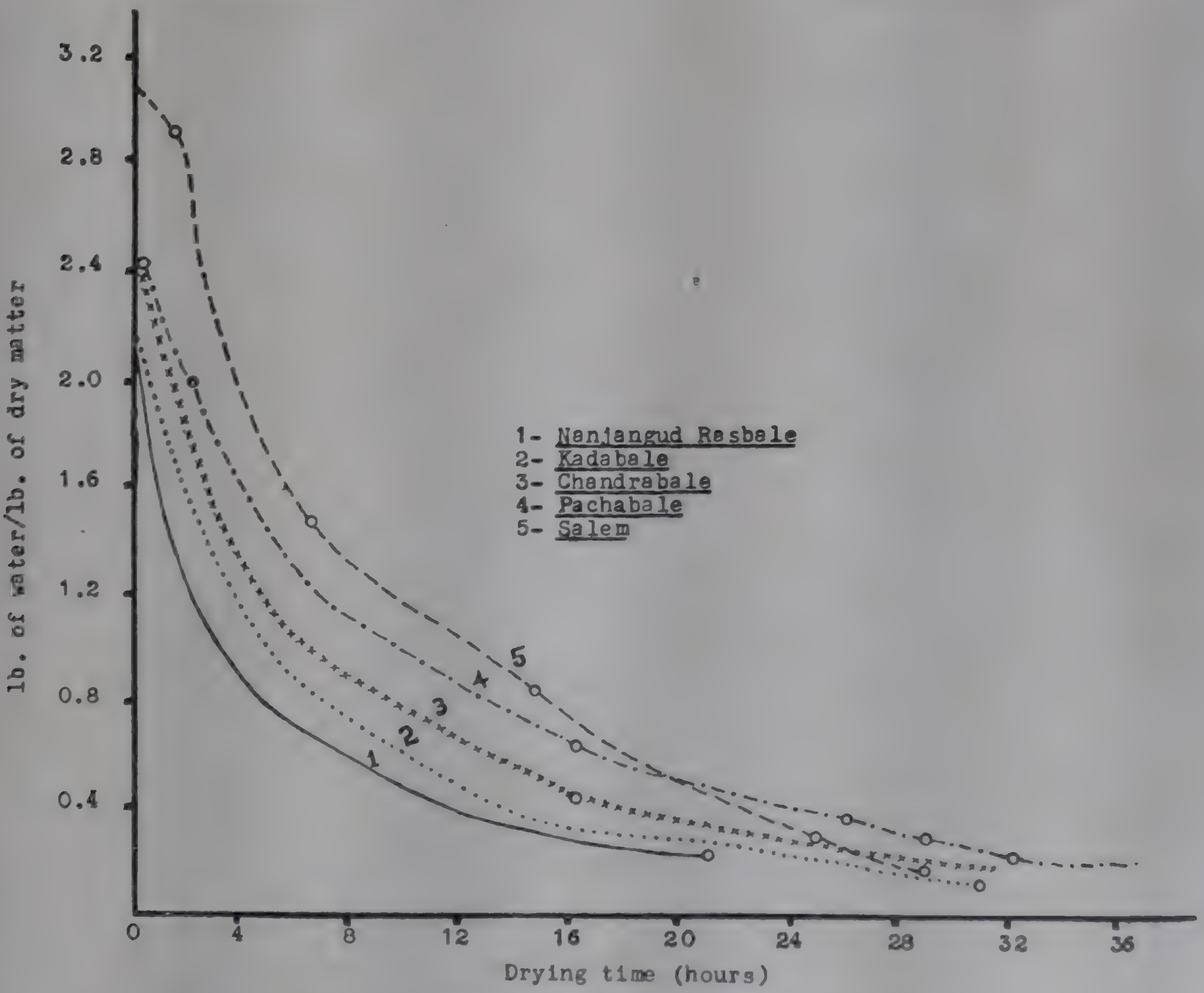

FIG. 6. Drying curves of different varieties of banana.

rate in the first 4 hours and then dry up faster than mature and slightly under-mature fruits. The drying of mature and slightly under-mature fruits continues to be more or less at a uniform rate which may probably be due to the uniformly firm texture where the rate of diffusion of moisture from the centre to the surface of the fruit is likely to be more uniform.

(*iv*) *Effect of variety:* The drying curves of *Pachabale, Kadabale, Salem, Chandrabale* and *Nanjangud Rasabale* varieties of bananas, obtained by drying in a cross-flow drier are given in Fig. 6. The results show that the drying rate is the fastest in the case of *Nanjangud Rasabale* variety and the slowest in the case of *Salem* variety. It is mainly influenced by the diameter of the fruit which is the smallest in the case of *Nanjangud Rasabale* and the largest in the case of *Salem* variety of the banana.

(*v*) *Effect of blanching:* In the case of *Pachabale* whole banana, steam blanching, for 15 minutes followed by pre-drying for 1 hour at 70°C helped in reducing the drying time by 3 hours when dried in a cross-flow cabinet drier.

(*vi*) *Moisture gradient in different layers of banana during dehydration:* It is known that in the case of vegetables, the rate of drying in later stages is governed by the speed at which the moisture diffuses from the centre to the surface of the piece. This results in slow drying, especially in thicker pieces. Ede and Hales[2] studied the diffusion phenomenon in the case of potato slices by determining the moisture content in successive layers at various stages during drying. Banana being a thick material it was of interest to study the rate of diffusion of moisture from the centre to the surface during the course of dehydration. Due to the heavy shrinkage and pulpy nature of the fruit, greater care was necessary in cutting the slices. Taking six fruits for the sample, slices (0.1″ thick) were removed upto the middle of each fruit and the moisture contents of the corresponding lots of the individual slices of respective thicknesses were determined by drawing samples at the end of different periods of drying. The results given in Fig. 7 show that the moisture always diffuses from a location where there is more of it and this phenomenon brings about a uniform level of moisture content within the piece. Since the moisture is continuously removed from the outer surface of the banana fruit by evaporation, this surface is always drier than the inner and deeper layers whereby a continuous flow of moisture is set up. The faster the drying, the more marked is the diffusion of moisture in the fruits investigated. The moisture distribution curves obtained in this study are consistent with what is known about the laws of diffusion.

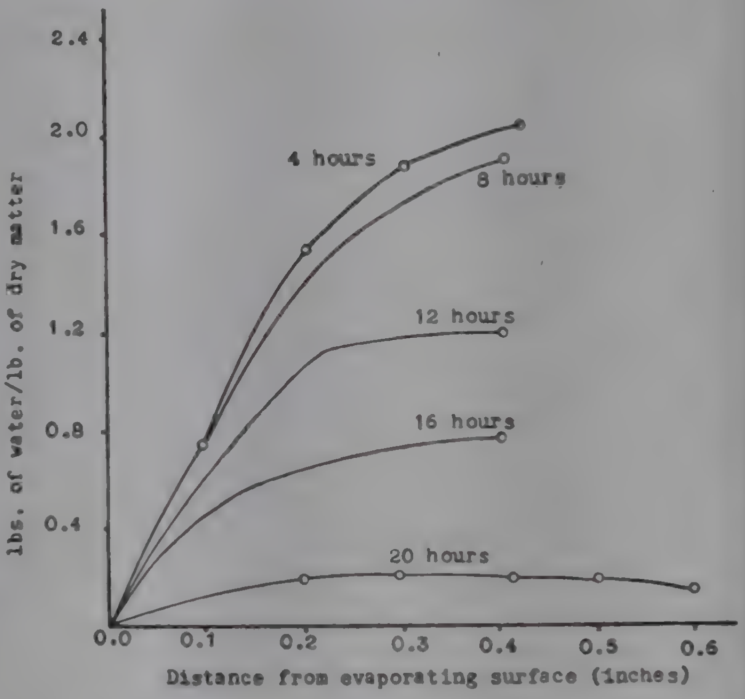

FIG. 7. Moisture-gradients in different layers of *Pachabale* banana during dehydration.

Unlike vegetables, fruits are not dried to very low moisture contents and, therefore, the diffusion of moisture from the centre to the surface is not the determining factor in the later stages of drying. The rate of drying is more or less propertional to the moisture ratios.

(*vii*) *Sun-drying:* The total drying times for sun-drying of different banana varieties in the month of March were 32, 48, 56 and 64 hours respectively for *Pachabale, Kadabale, Chandrabale* and *Salem* varieties with drying periods of 8 hours per day. The relative humidity of air varied from 22 to 59 per cent and air temperature from 34 to 39°C, as recorded between 2 and 2.30 p.m., everyday.

2. PINEAPPLE

(*i*) *Effect of nature of tray and type of drier:* In Fig. 8 are shown the drying curves for ¼″

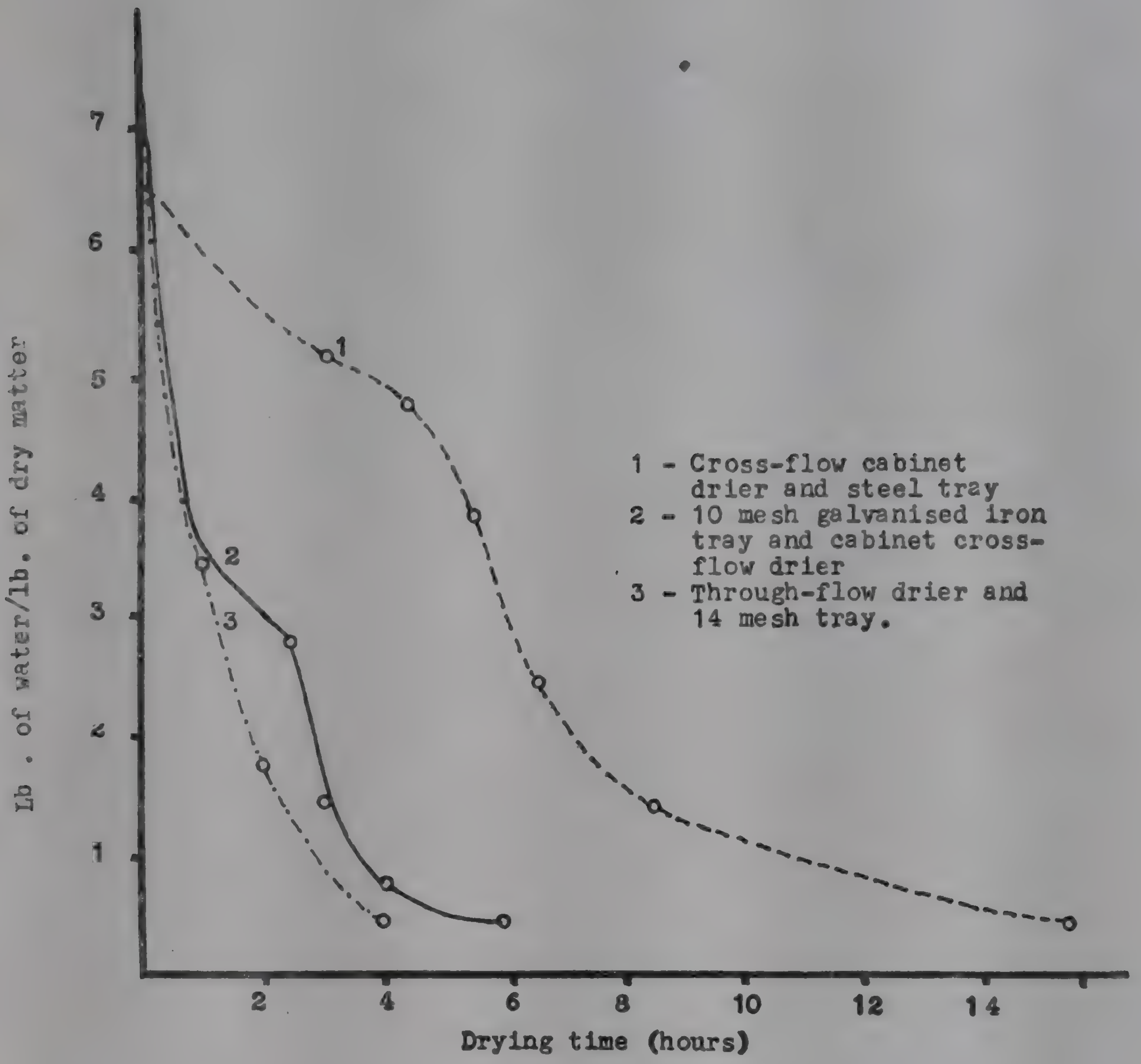

FIG. 8. Effect of nature of tray and type of drier on the drying rates of pineapple.

thick slices of pineapple dried in (*a*) a cross-flow drier using a stainless steel tray (*b*) cross-flow drier using a 10 mesh tray and (*c*) a through-flow drier using a 14 mesh tray. The drying time is reduced to 6 hours by using wire mesh trays which is due to the efficient heat transfer. Further reduction in drying time to 4½ hours could be obtained by drying in a through-flow drier. The drying temperatures in a cabinet drier were 74°C for the first hour, 66-70°C for the next 3 hours and 60°C thereafter; while in the through-flow drier they were 69°C for the first hour and 52-56°C thereafter. The air velocity was 4-6 feet per second in a cross-flow drier and 3-4 ft. per second in a through-flow drier.

(*ii*) *Effect of thickness of slices:* Drying rates obtained for ⅛″, ¼″ and ½″ thick slices when dried in a cross-flow drier, are presented in Fig. 9. These show that the drying is faster in the case of thinner slices. Drying time was 6 hours in ⅛″ thick slices as against 20 hours in ½″ thick slices and 16 hours in ¼″ thick slices.

(*iii*) *Effect of blanching:* In the case of pineapple slices (¼″ thick) steam blanched for 15 minutes and pre-dried at 70°C for 1 hour, the drying time was reduced by 7 hours when compared with the corresponding unblanched slices when both were dried in a cross-flow drier.

(*iv*) *Sun-drying:* Slices (¼″ thick) dried in the sun in 24 hours at the rate of 8 hours each day during 3 days at R.H. 84-94 per cent and air temperature 35-40°C.

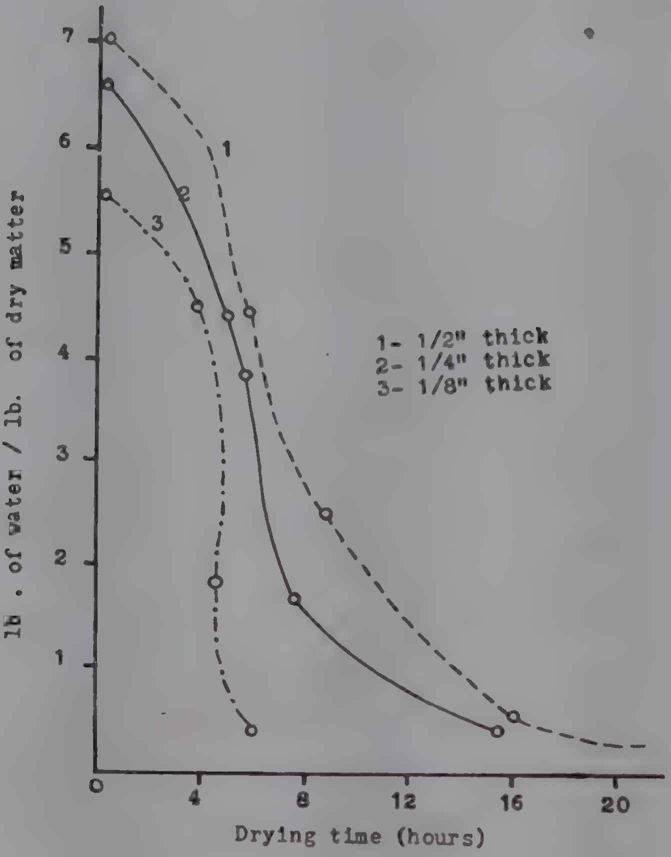

FIG. 9. Effect of thickness of slices on the drying rate of pineapple slices in cross-flow drier

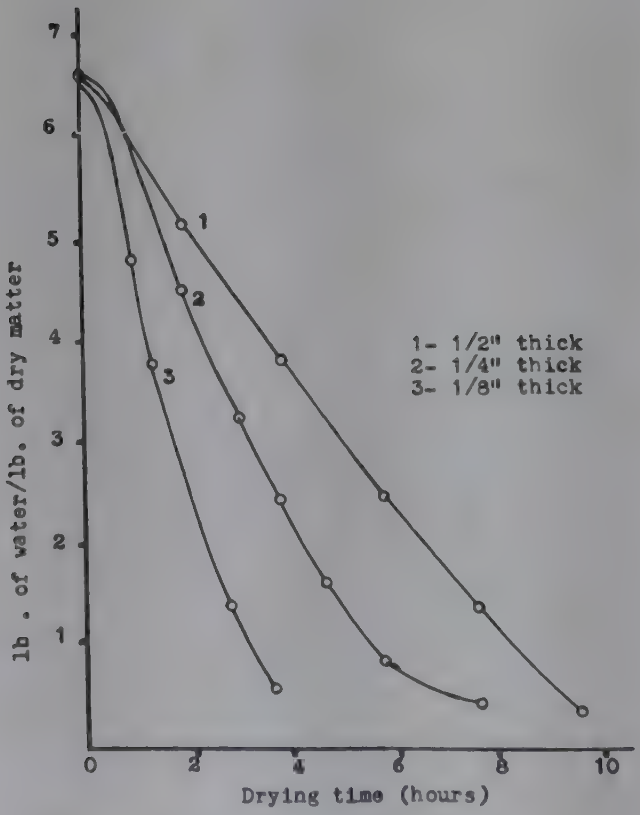

FIG. 10. Effect of thickness of slices on drying rates of papaya in cross-flow drier

3. PAPAYA

(*i*) *Effect of thickness of slices:* Drying rates obtained for $\frac{1}{8}''$, $\frac{1}{4}''$, and $\frac{1}{2}''$ thick slices dried in a cross-flow drier are shown in Fig. 10. These results indicate that the drying times of these slices were 4, 8 and 10 hours respectively *i.e.* thinner the slices, quicker is the drying.

(*ii*) *Effect of the type of drier:* Comparison of cross-flow and through-flow driers (Fig. 11) shows that drying rate for dehydration of papaya is much faster in a through-flow drier. Even 1" thick slices could be dried in 6 hours in a through-flow drier as against the drying time of 10 hours for $\frac{1}{2}''$ thick slices in a cross-flow cabinet drier. The drying temperatures were 70°C for 3 hours and 60-63°C thereafter in the case of a cross-flow drier, and 74-76°C for the first 2 hours and 60°C thereafter in the case of a through-flow drier.

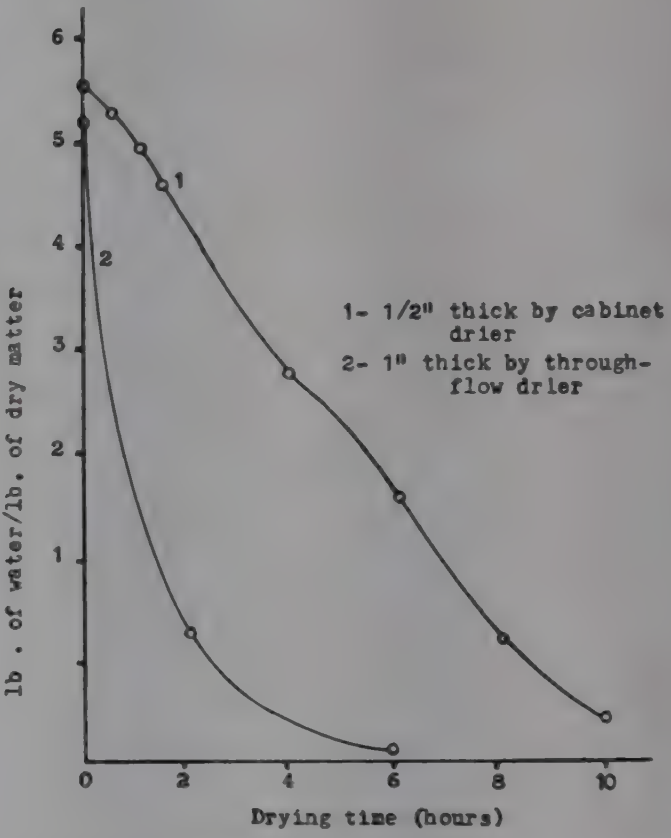

FIG. 11. Comparison of cross-flow and through-flow driers for drying rates of papaya slices (two thicknesses)

(*iii*) *Sun-drying:* One inch thick slices took 24 hours to dry in the sun (same conditions as referred to above for pineapples).

4. MANGO

Drying curves for *Raspuri* mango slices (1¼″ × 1″) given in Fig. 12 show that when dried in a through-flow drier at 72-74°C in the first hour, at 50-55°C in the next 2½ hours and at 45-46°C thereafter, required only 5½ hours for drying. In the case of *Badami* mango, the whole slices, when dried in a cross-flow cabinet drier at 63-64°C in the first 9 hours and at 58-60°C thereafter, required a drying time of 18 hours.

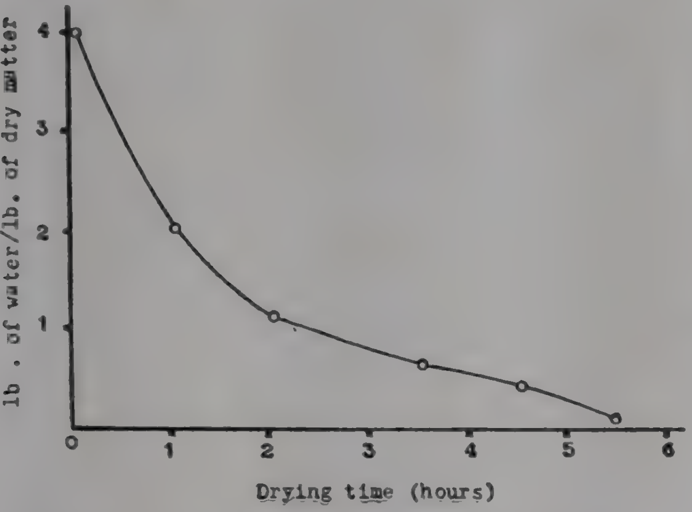

FIG. 12 a. Drying curve of *Raspuri* 1¼″ thick mango slices (through-flow drier)

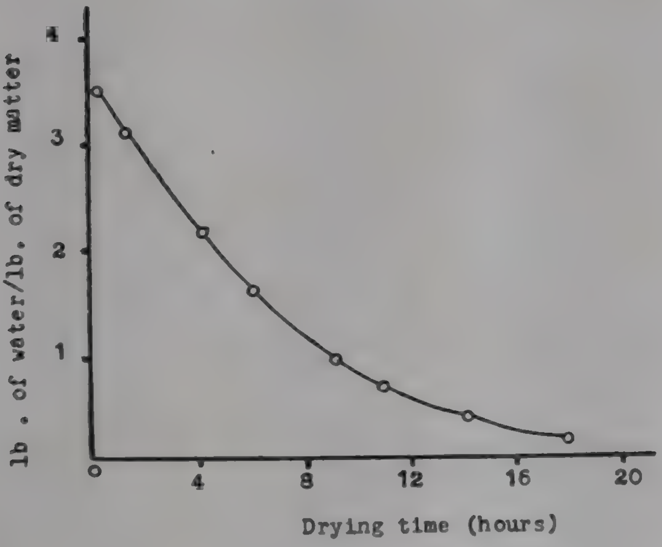

FIG. 12 b. Drying curve of *Badami* mango whole slices (cross-flow drier).

Summary

An investigation on the drying rates of some tropical fruits as affected by various factors has shown that (*i*) through-flow drier is much more efficient than cross-flow cabinet drier when comparing the drying rates of banana, pineapple, papaya and mango fruits under comparable conditions. (*ii*) Drying is faster in thinner slices than in thicker ones in all the fruits studied. In the case of bananas, drying rates are fastest in the case of *Kadabale* and *Nanjangud* varieties due to their smaller diameters. (*iii*) In the case of *Pachabale* banana, slightly over-mature fruit dries at a slower rate during the first 4 hours but subsequently the rate is faster than in the case of mature and slightly under-mature fruit. (*iv*) Drying time is reduced considerably by steam blanching the *Pachabale* whole bananas and ¼″ thick pineapple slices when dried in a cabinet drier. (*v*) Drying time can be reduced substantially by using wiremesh trays instead of stainless steel or aluminium trays. This is mainly due to efficient heat transfer. (*vi*) Drying times were 32, 48, 56 and 64 hours respectively in whole fruits of *Pachabale*, *Kadabale*, *Chandrabale* and *Salem* varieties of bananas during sun-drying. In the case of ¼″ thick pineapple and 1″ thick papaya slices the drying time was 24 hours. (*vii*) Unlike the vegetables, the bananas are not dried to low moisture contents. The diffusion of moisture from the centre to the surface is not the determining factor in the later stages of drying. The rate of drying is more or less proportional to the moisture ratios during the entire period of drying.

Acknowledgment

Grateful acknowledgment is made to Drs V. Subrahmanyan, Director, A. Sreenivasan, Deputy Director, Girdhari Lal, Assistant. Director (since retired) for their interest in this investigation and G. S. Siddappa, Assistant Director for going through the manuscript. Thanks are also due to Dr S. S. Kalbag for providing facilities in the technology block.

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STUDIES ON DEHYDRATION OF SOME TROPICAL FRUITS—PART III. PACKAGING AND STORAGE ASPECTS

By B. S. Bhatia and H. D. Amin*

(Central Food Technological Research Institute, Mysore)

The absorption and retention of SO_2 during sulphuring and sulphiting, and drying rates as affected by various factors have been described in earlier papers in this series[1,2]. In the present communication, packaging and storage studies of some dehydrated tropical fruits are discussed.

Materials and Methods

Preparation of the experimental material and the methods used for the estimation of moisture and SO_2 have already been described[1]. The equilibrium relative humidity (E.R.H.) was determined by Wink's method[3], using standard salt solutions. Non-enzymatic browning was measured in dehydrated fruits by soaking 10 g. of the material in 70 per cent alcohol for 16 hours, extracting the colour by repeated grinding in a pestle and mortar, filtering and making the extracts to a known volume (50 ml.) and then measuring the optical density at 420 mμ. The value was expressed in terms of original material by multiplying with the dilution factor (5 times).

Organoleptic quality was determined by a panel of tasters selected from the staff and students of the Institute, on the score card system in respect of colour, flavour and texture using a 10 point score for each.

Results and Discussion

1. *Equilibrium Relative Humidity* (E.R.H.): The measurement of E.R.H. of dehydrated fruits is of considerable importance for a systematic study on packaging, as it determines the limits of dehydration, hygroscopicity and other changes such as colour, texture, mould growth etc., of the product at different temperatures and relative humidities.

The initial moisture contents of the products taken for this study were 19.0 per cent in banana, 21.5 per cent in pine-apple, 21.9 per cent in papaya and 17.2 per cent in *Raspuri* mangoes.

The degree of browning, SO_2 and moisture contents were determined for samples exposed to different relative humidities at the end of the experiment *i.e.*, about 45 days.

The relationship between the equilibrium moisture content, number of days the product took to reach the equilibrium at a particular relative humidity, degree of browning and SO_2 content, has been presented in Tables I-IV for banana, pineapple, papaya and mango respectively. Humidity moisture equilibrium curves for these products are given in Figures 1 and 2.

The results show that: (*i*) considering the overall organoleptic quality of the fruit with respect to colour, texture and flavour, the best relative humidity for storage was found to be 60 per cent in the case of banana, mango and papaya and 51 in the case of pineapple; (*ii*) while there was no mould growth in the case of mango at any relative humidity, in pineapple, mould growth occurred at relative humidities of 67 and above, while in papaya and banana, it occurred only at 90 per cent relative humidity; (*iii*) in general, non-enzymatic browning decreased and SO_2 content increased with decrease in relative humidity; (*iv*) the time required to reach equilibrium was more in the lower ranges of relative humidity, though in some cases, it was both at the lower and the higher ranges.

2. *Effect of different levels of SO_2 on browning in dehydrated Pachabale banana during storage at room temperature (24-30°C) and 37°C:* The data presented in Table V, show that browning is proportional to the concentration of SO_2 during all stages of storage. At 37°C, the samples containing less than 1240 p.p.m. SO_2 had reached a stage of browning after 13 weeks of storage, when their colour was no longer acceptable.

At SO_2 level of 1500 p.p.m. and above, the shelf-life was 13 weeks at 37°C and at a level

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* Student of Fruit Technology Associateship Course (1958-60) and now Lecturer at the Agricultural College, Junagadh.

TABLE I. *Relation of equilibrium moisture content, relative humidity, time required to reach equilibrium, degree of browning (O.D. at 420 mμ) and SO_2 content of whole Pachabale banana exposed to different relative humidities at 37°C*

Relative humidity %	Days required to reach equilibrium moisture	Equilibrium moisture %	Browning	SO_2 (p.p.m.)		Remarks
				Wet basis	Moisture free basis	
90	31	...	...	...	...	Free water after 12 days; mould after 31 days
79	24	28.7	...	...	...	Brown; texture soft; easy to eat
67	22	27.4	...	...	...	Reddish brown; moderately soft; texture good
60	22	15.2	1.91	352	415	Slightly hard; light brown; moderately attractive
51	13	13.9	1.88	660	766	Colour and texture good; slightly hard to cut
43	45	13.6	1.76	870	1007	Colour bright and good; slightly hard
32	45	8.6	0.855	1212	1326	Colour very attractive; hard
20	45	7.4	0.495	1560	1685	Colour light yellow; very hard
11	45	7.1	0.315	1720	1851	Very attractive; light yellow; very hard

TABLE II. *Relation of equilibrium moisture content, relative humidity, time required to reach equilibrium, degree of browning (O.D. at 420 mμ) and SO_2 content of 1/4″ thick pineapple slices exposed to different relative humidities at 37°C*

Relative humidity %	Days required to reach equilibrium moisture	Equilibrium moisture %	Browning	SO_2 (p.p.m.)		Remarks
				Wet basis	Moisture free basis	
90	15	46.8	3.34	...	...	Mouldy after 12 days
79	11	39.2	2.81	...	...	Mouldy after 30 days; brown after 13 days
67	14	37.2	2.01	335	533	Mouldy after 30 days; slightly brown after 13 days
60	5	20.3	1.96	...	...	Unattractive colour; much brownish on sides
51	4	19.2	1.88	1456	1827	Colour bright; texture good
43	2	11.1	1.36	744	836	Colour good; hard texture
32	8	9.2	1.04	532	585	Colour bright; hard texture
20	15	9.8	0.84	...	...	Very hard; shrivelled
11	17	7.5	0.64	...	...	-do- -do-

TABLE III. *Relation of equilibrium moisture content, relative humidity, time required to reach equilibrium, degree of browning (O.D. at 420 mμ) and SO_2 content of 1″ thick papaya slice exposed to different relative humidities at 37°C*

Relative humidity %	Days required to reach equilibrium moisture	Equilibrium moisture %	Browning	SO_2 (p.p.m.)		Remarks
				Wet basis	Moisture free basis	
90	9	...	...	...	...	Slightly brown after 11 days and mouldy after 14 days
79	12	29.1	...	654	923	Very brown after 11 days, deep brown after 24 days and very deep brown after 29 days; at the end stale and fairly soft
67	19	25.1	4.89	500	664	Brown on sides; free water given out after 24 days; very brown; stale and slightly soft after 29 days
60	3	18.2	4.43	500	611	Reddish yellow; texture and appearance good
51	7	14.0	3.84	754	859	Reddish brown; not very attractive; moderately hard
43	14	12.2	3.66	977	1090	Deep yellow with reddish tinge; hard
32	21	10.4	4.52	1207	1305	Reddish yellow; very hard; slightly shrivelled
20	24	7.6	3.29	1561	1815	-do- -do-
11	34	3.5	0.35	...	...	Yellowish red; very-very hard

TABLE IV. *Relation of equilibrium moisture content, relative humidity, time required to reach equilibrium, degree of browning (O.D. at 420 mμ) and SO_2 content of $1\frac{1}{4}''$ thick Raspuri mango slices exposed to different relative humidities at 37°C*

Relative humidity %	Days required to reach equilibrium moisture	Equilibrium moisture %	Browning	SO_2 (p.p.m.)		Remarks
				Wet basis	Moisture free basis	
90	33	46.9	...	...	...	Slightly brownish black after 31 days; much free water
79	30	32.6	2.58	144	214	Brown; free water all over the surface; stale
67	22	21.6	...	...	...	Slightly brown; slight free water on the surface; soft
60	19	...	...	576	620	Bright yellow; good texture; acceptable flavour
51	21	10.0	...	...	...	Deep yellowish to light red; moderately hard
43	27	9.7	2.51	956	1058	Deep yellow; slightly hard, no stale flavour
32	23	8.5	2.44	1632	1779	Yellowish; hard
20	30	8.5	2.28	1095	1217	Yellowish with reddish tinge; flavour good; very hard
11	34	8.3	1.93	705	772	Yellowish, flavour good; very hard

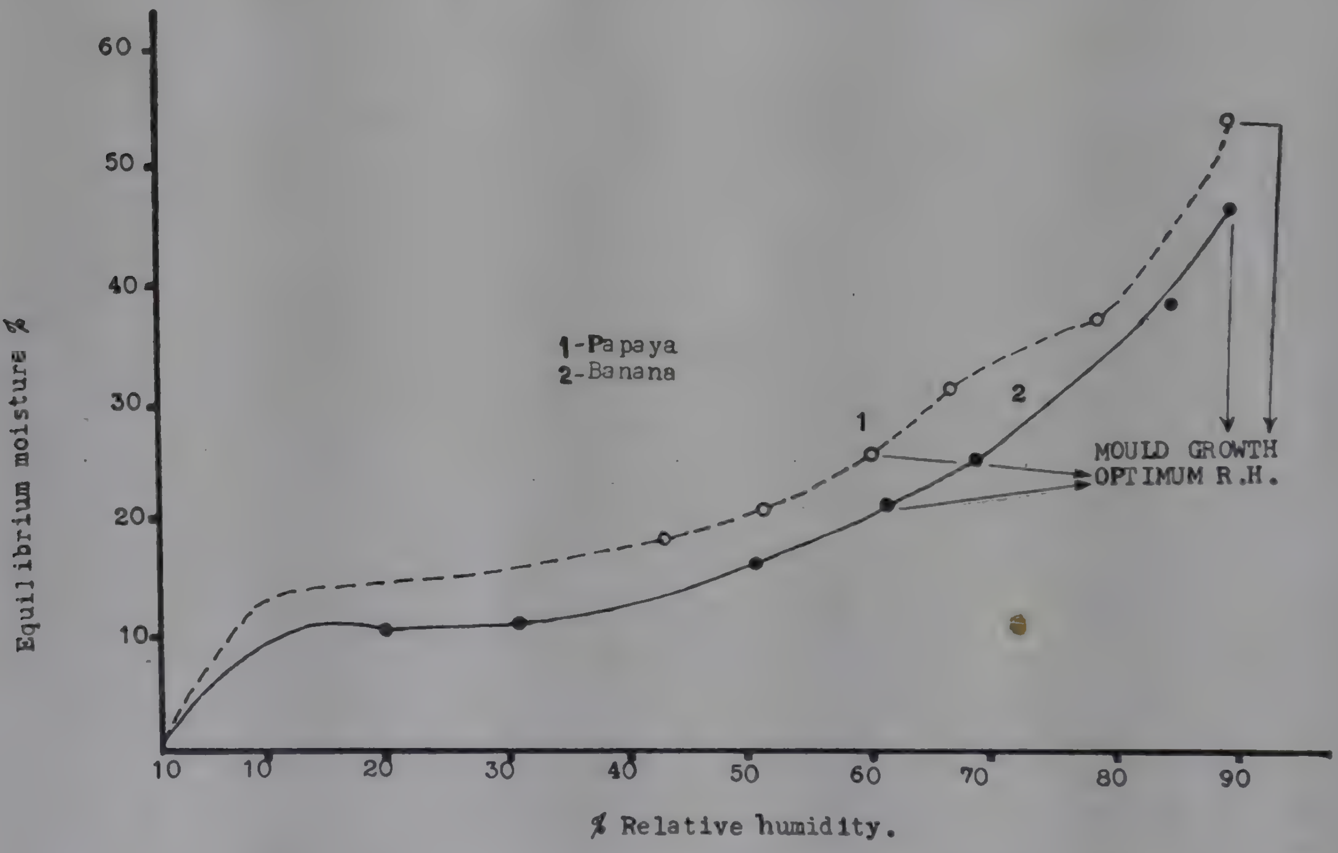

FIG. 1. Humidity moisture equilibrium curves in dehydrated papaya and banana.

of 1240 p.p.m. of SO_2, the samples were acceptable when examined after 26 weeks of storage at room temperature. It would, therefore, appear from the data that a shelf-life of about 4-5 months at 37°C and 8-12 months at room temperature (24-30°C) may reasonably be expected in bananas containing about 1500 p.p.m. SO_2. Shelf-life may be further enhanced by increasing the SO_2 content of the product to 2000 p.p.m. and above. Most of the SO_2 is lost after a storage period of 11 weeks at 37°C.

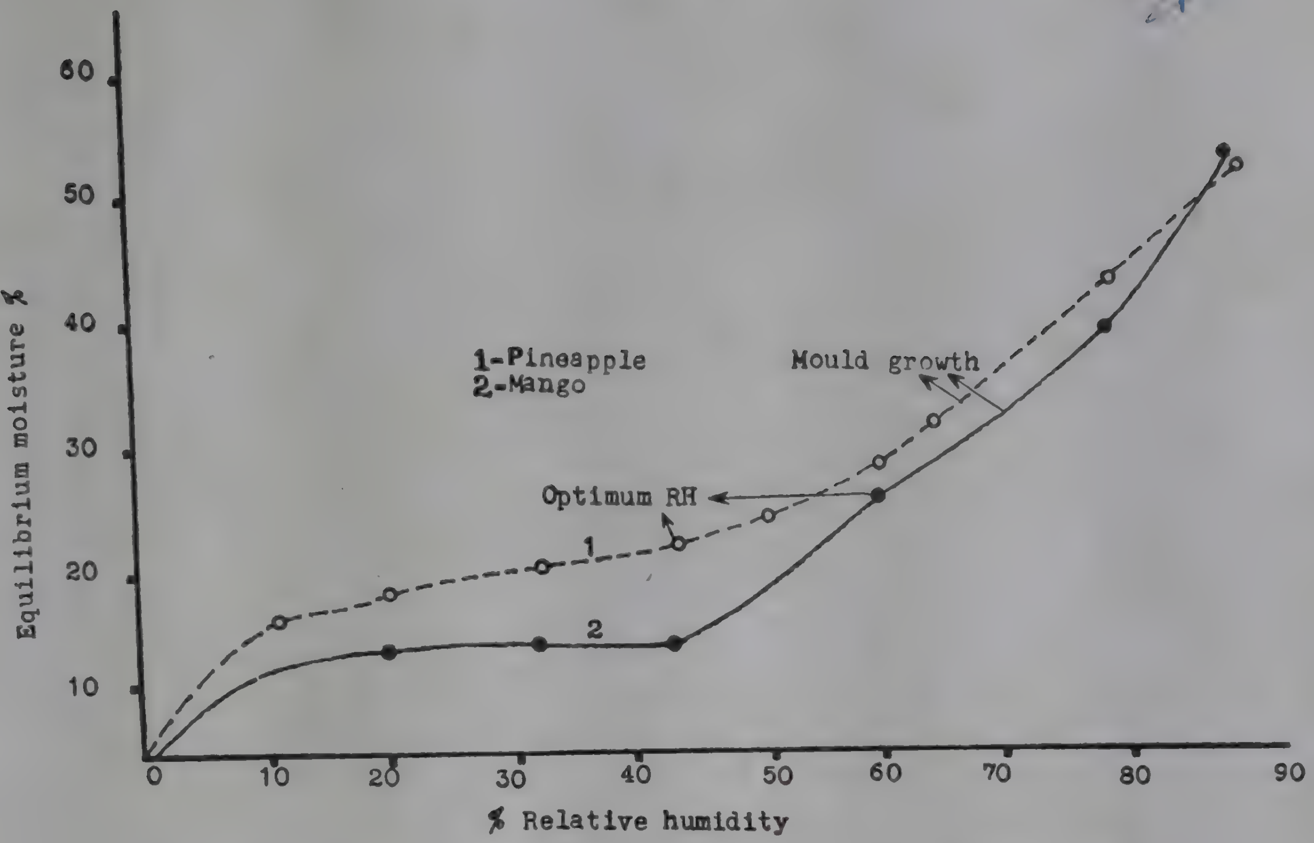

FIG. 2. Humidity moisture equilibrium curves in dehydrated pineapple and mango.

TABLE V. *Effect of different levels of SO_2 on browning in Pachabale dehydrated bananas during storage at room temperature (24-30°C) and 37°C*

Sulphuring time (hrs)	Moisture	SO_2 (p.p.m.)		Browning (.OD. at 420 mμ) after storage (in weeks)				Browning after 22 weeks of storage at room temperature (O.D. at 420 mμ)
		Initial	After 11 weeks at 37°C	0	9	13	17	
1.0	13.1	382	53	0.79	3.34	5.00	Unacceptable	2.25
1.5	12.1	648	59	0.72	3.29	3.91	do	2.22
2.0	16.3	1240	91	0.72	2.92	3.69	4.43	1.19
2.5	13.6	1519	113	0.38	2.84	3.10	4.12	...
3.0	19.0	2689	274	0.30	2.80	2.58	3.66	...

3. *Effect of type of drier and container on browning in dehydrated bananas during storage:* The data in Table VI show that the product dried in a through-flow drier offers better resistance against browning when packed in screw-cap glass jars stored at room temperature (24-30°C) and at 37°C. The beneficial effect is due to less initial heat damage because of the shorter period of drying in through-flow drier and this difference continues during storage. Lower initial moisture also contributed to this effect. The polyethylene bags (250 gauge) appeared to be better than bottles but it may be mentioned that the major part of storage was during the season when relative humidity in the atmosphere of Mysore was fairly low (30-40 per cent), which resulted in the reduction of moisture in samples stored in polyethylene bags, thereby affording more protection against browning. In another set of experiments, banana slices packed in polyethylene bags were found to be more brown than those stored in bottles at 37°C, probably due to the greater surface area of the slices exposed to abundant supply of oxygen in polyethylene bags.

4. *Effect of size and maturity of pachabale banana on browning in dehydrated fruit during*

TABLE VI. *Effect of type of drier and container on browning in dehydrated bananas*

Type of drier	Moisture %	SO$_2$ (p.p.m.)		Browning (O.D. at 420 mμ) at 37°C after storage (weeks)								Browning (O.D. at 420 mμ) and SO$_2$ content at RT (24-30°C) after 22 wks. storage in glass jars	
				Polyethylene bags				Glass jars					
		Initial	After 11 weeks at 37°C	0	9	13	17	0	9	13	17	SO$_2$ (p.p.m)	Browning
Cross-flow	24.4	1148	507	...	1.12	1.04	2.28	...	1.64	2·51	2.92	523	1.83
Through-flow	15.8	1971	672	...	1.26	1.24	1.11	...	1.24	2.19	2.31	682	1.00

TABLE VII. *Effect of size and maturity of Pachabale banana on browning during storage*

	Moisture %	SO$_2$ (p·p.m.)		Browning (O.D. at 420 mμ) after storage (in weeks)			
		Initial	After 11 weeks at 37°C	0	9	13	17
Size:							
Large (9″ long) ...	32.1	1629	158	0.36	0.99	1.80	1.86
Medium (7″ long) ...	20.6	1706	44	0.51	0.79	2.65	2.96
Small (5″ long) ...	21.4	1764	67	0.53	1.68	2.67	3.05
Maturity:							
Slightly over-mature ...	23.0	1613	138	0.54	1.44	2·76	3·01
Mature ...	25.4	1778	283	1.36	1.64	2.51	2.92
Slightly under-mature ...	21·6	...	89	1·23	0·82	2·31	2.40

TABLE VIII. *Browning during storage in different varieties of banana at (RT 24-30°C) and 37°C*

Variety	Reducing sugars %	Moisture %	SO$_2$ (p.p.m.)		Browning (O.D. at 420 mμ) after storage (in weeks)				Browning at RT (O.D. at 420 mμ) after storage (in weeks)		
			Initial	After 11 weeks at 37°C	0	9	13	17	9	11	17
Chandrabale ...	46	21.2	1523	235	1.04	1.42	2.88	...	1.04	1.66	1.76
Kadabale ...	69	22.8	1642	212	0.56	1.40	2.47	2.54	1.22	1.76	1.78
Pachabale ...	65	24·4	1148	283	1.36	1.64	2·51	2.92	...	...	2.01
Salem ...	71	22.5	764	252	1.60	1.59	2.88	4.51	1.59	1.73	2.19

storage: The data in Table VII show that browning is comparatively less pronounced in the case of large size fruits which may be due to less surface area exposed to oxygen during dehydration and storage. Also, the medium and the small size fruits retained less amount of SO$_2$ during storage thus resulting in greater browning.

With respect to the effect of maturity it was observed that the slightly under-mature fruits had a tendency to turn less brown probably due to less concentration of sugar. It was further seen that the higher retention of SO$_2$ during storage tended to reduce browning.

5. *Browning in different varieties of dehydrated banana during storage:* Data in Table VIII show that although initial browning was less in the case of *Kadabale* banana compared with *Chandrabale*, after storage for 9 and 11 weeks at 37°C, both of them were brown to about the same degree. Since SO$_2$ and moisture contents were almost the same in both cases, this may probably be due to higher sugar content in *Kadabale* variety. Browning in *Pachabale* and *Salem* varieties was practically similar both initially and after storage for 11 weeks at 37°C, but after 17 weeks, the *Salem* variety was more brown than the *Pachabale*

TABLE IX. *Browning in ½" thick Pachabale banana slices sulphured for different periods, dried and stored in different containers at 37°C*

Sulphuring time (hours)	Container	SO_2 (p.p.m.)		Browning (O.D. at 420 mμ) after storage (in weeks)			
		Initial	After 11 weeks	0	9	13	17
3	Glass jar	3643	505	0.38	0.51	1.42	1.88
2	do	2692	289	0.38	0.51	1.59	2.47
2	Polyethylene bag (250g)	2692	134	0.38	0.71	2.10	2.47

variety. Behaviour of the *Salem* banana stored at room temperature was similar.

6. *Browning in ½" thick Pachabale banana slices sulphured for different periods and stored in different containers at 37°C:* The data presented in Table IX indicate that the slices sulphured for 3 hours, dried and stored in glass bottles showed less browning than those sulphured for 2 hours. The extent of browning in the slices sulphured for 2 hours and stored in screw-cap glass jars and polyethylene bags was similar. However, the loss of SO_2 was more in samples stored in polyethylene bags.

7. *Browning in dehydrated pineapple and papaya during storage:* Data presented in Table X about SO_2 contents and degree of browning in the case of dehydrated pineapple and papaya examined after storage period of 8 weeks at 37°C show that the products, although showing increased browning, were still acceptable with respect to colour, flavour and texture. About ⅓ of initial SO_2 was still retained by this time.

TABLE X. *Browning in dehydrated pineapple and papaya during storage at 37°C*

Fruit	SO_2 (p.p.m.)		Browning (O.D. at 420 mμ) after storage (in weeks)		
	Initial	After 11 weeks	0	4	8
Pineapple ½" thick slices ...	1803	704	0.24	1.81	4.89
Papaya 1" thick slices...	2323	864	2.58	2.76	7.60

8. *Effect of storage on organoleptic quality of dehydrated fruits:* The data collected can be summarised as follows: (*i*) The products dried in the through-flow drier packed in glass jars and stored at room temperature and 37°C were better than the comparable samples dried in the cross-flow cabinet drier. (*ii*) The samples packed in polyethylene bags and stored at 37°C were better than those packed in glass bottles. (*iii*) After storage at 37°C for 5 months, the samples packed in glass bottles were unacceptable in colour but were fairly acceptable after reconstitution.

(*iv*) During a storage period of 5 months at 37°C, *Chandrabale*, *Kadabale* and *Salem* varieties of bananas became unacceptable in colour while *Pachabale* variety was still acceptable.

Summary

An investigation on the packaging and storage of some dehydrated tropical fruits have shown that (*i*) best equilibrium relative humidity is 51 per cent for dried pineapple and 60 per cent for dried banana, mango and papaya, (*ii*) in general, a shelf-life of 4-5 months at 37°C and 8-12 months at room temperature (24-30°C) may reasonably be expected in dehydrated bananas, pineapples, papayas and mangoes containing about 1500 p.p.m. SO_2 and 15-20 per cent moisture. Shelf-life may be further enhanced by increasing the SO_2 content of the products to 2000 p.p.m. and above, (*iii*) initial improvement in the quality of dehydrated fruits obtained by using through-flow drier as against cross-flow cabinet drier was maintained during storage.

Acknowledgment

Grateful acknowledgment is made to Drs V. Subrahmanyan, Director, A. Sreenivasan, Deputy Director, Girdhari Lal, Asst. Director (since retired) for their interest in this investigation and to G. S. Siddappa, Asst. Director for going through the manuscript. Thanks are also due to Dr S. S. Kalbag for providing facilities in the technology block.

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STUDIES ON DEHYDRATION OF SOME TROPICAL FRUITS—PART IV. ORGANOLEPTIC QUALITY OF PRODUCTS

By B. S. Bhatia, H. D. Amin* and Girdhari Lal§

(Central Food Technological Research Institute, Mysore)

In the earlier papers[1,2,3], retention of SO_2, drying rates and packaging and storage aspects of some dehydrated tropical fruits have been described. In the present paper, the organoleptic quality of the products is discussed.

Materials and Methods

These have been described in the earlier papers[1,3]. For reconstitution, to 10 g. of material in a beaker kept covered with a watch glass 150—200 ml. of distilled water was added and the contents brought to a boil within three minutes. Boiling was continued for 2, 5, 10, 15, 20, 25 and 30 minutes. The fruit pieces were drained off and water sticking removed with the help of a filter paper and the pieces then weighed.

Results and Discussion

Organoleptic quality of fruits eaten as such: Apart from colour and flavour, texture is highly important for giving a feeling of good bite while eating the dehydrated fruit as such. The main factor determining good texture is the optimum moisture content. Although fruits can be dried to a low moisture content for improving their shelf-life, this affects their texture adversely. Products of reasonably good texture were obtained in the case of banana, pineapple, papaya and mango which were dehydrated to 18-20 per cent moisture. In papaya, the texture and eating quality were better in 1″ thick slices than in $\frac{1}{8}$″, $\frac{1}{4}$″ and $\frac{1}{2}$″ thick slices. In pineapple, the best texture was attained in the case of $\frac{1}{2}$″-1″ thick slices. In the case of banana, the texture was best retained in the whole fruit or in $\frac{1}{2}$″ thick slices. In the case of mango, the texture was fairly acceptable, *Badami* variety being slightly better than *Raspuri* variety. The colour of the dehydrated products was brighter in the steam-blanched than in the unblanched pineapples.

Organoleptic quality of reconstituted dried fruits: Capacity for rapid and complete dehydration is one important characteristic in a dehydrated product. The amount of water required and the length of the soaking time for reconstitution vary according to the drying ratio of each fruit. In the case of banana, reconstitution was studied in water, sugar syrup of different concentrations and also by soaking in water followed by dipping in syrup. It will be seen from Fig. 1 that reconstitution is easier and quicker in the case of slices. Reconstitution was not complete in the case of whole fruits even after 25 minutes. Slices, however, reconstituted well by that time.

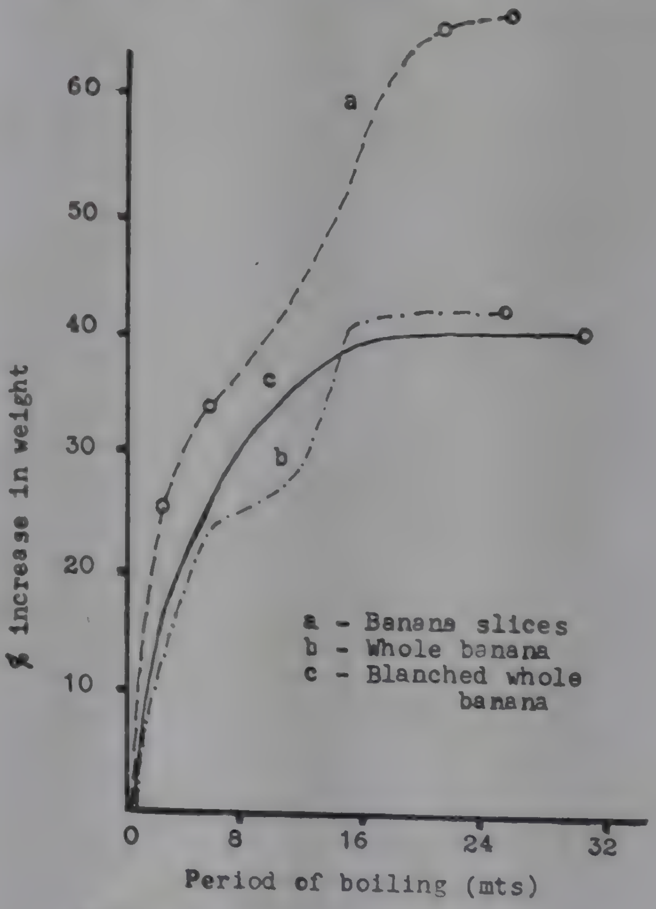

FIG. 1. Reconstitution curve for banana

Taste panel evaluation of dehydrated whole fruit and slices reconstituted after boiling for 20 minutes in syrup showed that flavour was not satisfactory in the case of products reconstituted in water. Dehydrated *Pachabale* banana and 10 per cent sugar syrup appeared to be the best for reconstitution. Dehydrated *Salem*, *Kadabale* and *Chandrabale* varieties of banana were starchy in taste. The last one was slightly superior to the former two varieties. Reconstitution time was 25 minutes in the case of *Chandrabale* and 15 minutes in other varieties.

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* Student of Fruit Technology Associateship Course (1958-60) and now Lecturer at the Agricultural College, Junagadh.

§ Assistant Director, Fruit Technology Division (since retired).

In general it was observed that as the syrup strength increased from 0° to 15° Brix, the product improved in flavour both in the dehydrated and sun-dried banana in all the other varieties except *Pachabale*. Soaking before reconstitution was generally beneficial. When the fruits were soaked in water for 2-3 hours and then boiled for 10 minutes in the same water after adding sugar to raise the Brix to 15°, the reconstituted products were much better in flavour and texture.

The reconstitution curves obtained by using boiling water in the case of different sizes of dehydrated pineapple, papaya and mango are given in Figures 2, 3 and 4. In all the cases, the time required for absorption of a given quantity of water was directly proportional to the piece thickness.

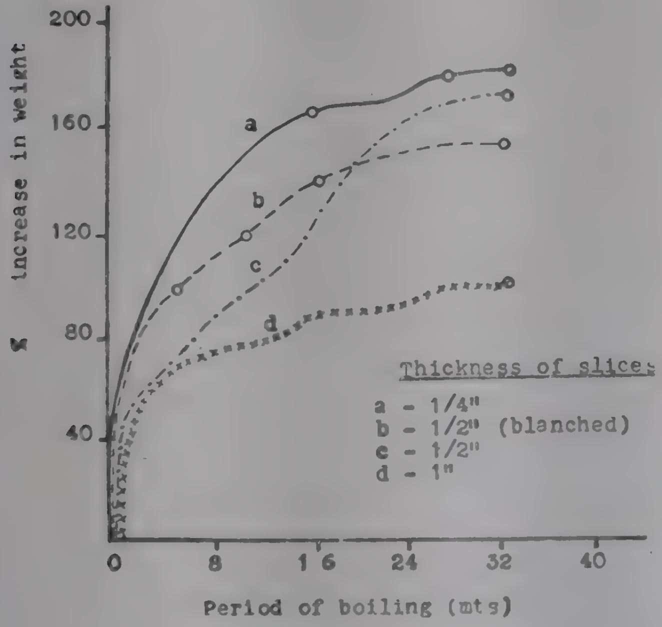

FIG. 2. Reconstitution curve for pineapple.

Steam blanching for 15 minutes before drying resulted in faster reconstitution in the case of pineapples. In the case of papaya reconstitution in 5° Brix syrup was satisfactory.

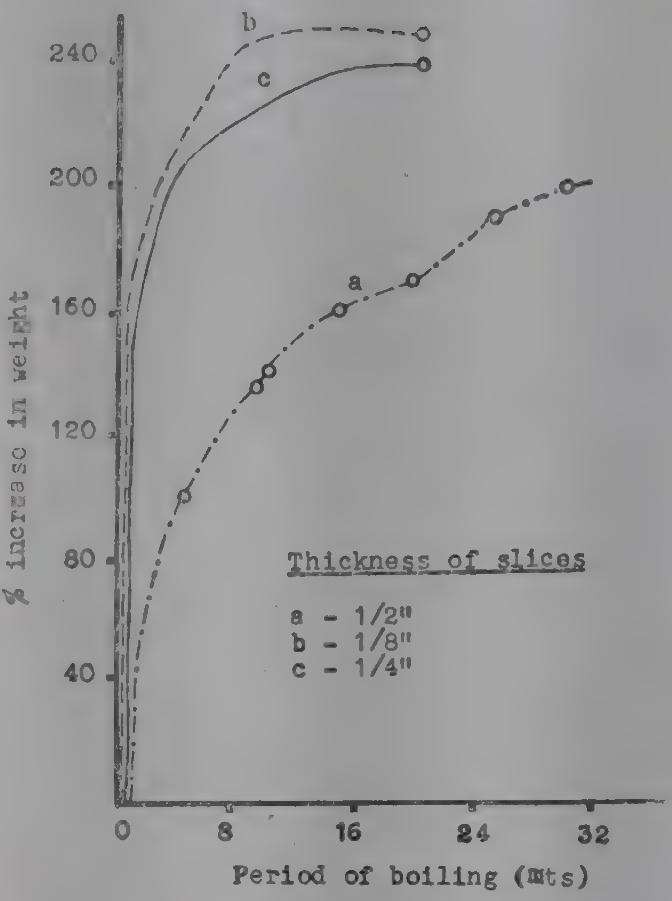

FIG. 3. Reconstitution curve for papaya.

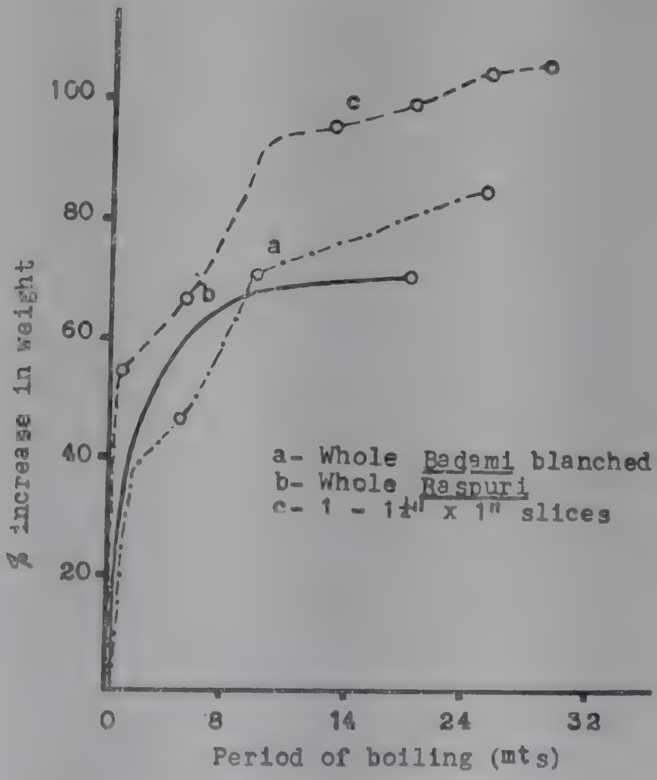

FIG. 4. Reconstitution curve for mango.

Improvement of texture of dried fruits by packing at high moisture content: In recent years, the dried fruits with higher moisture content have met greater consumer acceptance[4,5] both in India and abroad as they are tender, moist, palatable and ready to eat. They are, however, more susceptible to spoilage by yeasts and moulds. McBean and Johnson[6] recommended the use of propylene oxide in conjunction with a heat sealed container to prevent microbial growth in prunes packed at high moisture levels so as to enable prunes to be eaten as such under the category of '*convenience food*' without any rehydration. In the case of high moisture dried prunes (35 per cent moisture), Nurry, Miller and Berkke[7] who studied the five preservatives, *viz*., propylene oxide, potassium sorbate, calcium propionate, vitamin K_5 and dehydro-acetic acid, observed that potassium sorbate had the maximum antimicrobial effect.

Pachabale variety of banana and the 1″ thick pineapple slices were sulphured and dehydrated in a cabinet drier to a moisture content of 30-35 per cent, dipped in 2 per cent potassium sorbate solution for 2 minutes using equal weight of the solution for the fruits and again dried for about an hour to remove the superficial layer of water. In one case the fruits thus dried were subjected to a fine spray of yeast (*Saccharmoyces rouxii*) containing 90 million cells per ml, and stored in screw capped glass bottles at room temperature (24-30°C). Control samples without spraying with yeast were also stored. There was not any growth of yeast upto a storage period of 11 weeks in both the cases.

In the case of the treated samples exposed to 90 per cent relative humidity for 11 days at room temperature (24-30°C) sulphuring alone was not effective, while potassium sorbate was highly effective at a concentration of 0.5 per cent in pineapple and 2 per cent in banana (Table I). These preliminary experiments indicate the possibility of preparing high moisture dehydrated fruits.

TABLE I. *Effect of SO$_2$ and potassium sorbate treatment in high moisture dehydrated banana and pineapple on the appearance of mould at 90% R.H.*

Fruit	Treatment	Sulphur dioxide p.p.m.		Average no. of days for the appearance of mould
		Absorption	Retention	
Banana (whole)	SO$_2$ alone	...	1,200	42
	SO$_2$ and 2% pot. sorbate	811	1,034	No mould attack
Pineapple (1″ thick slices)	SO$_2$ alone	...	902	20
	SO$_2$ and 0.5% pot. sorbate	1,219	452	No mould attack
	SO$_2$ and 2% pot. sorbate	...	629	No mould attack

Summary

For eating as such, reasonably good texture is obtained in dehydrated fruits of thickness not less than 1/2″ and of moisture content of 18-20 per cent. Reconstitution trials using water and 5-15° brix sugar syrup indicated poor reconstitution in banana but this could be improved by initial soaking of the fruit for about two hours in water. Except in papaya where 5° Brix syrup gave good results, best stewed fruits were obtained by boiling in 10° Brix sugar syrup for 20-30 minutes. Reconstitution was quicker in thinner slices. High moisture content (30-35 per cent) dried banana and pineapple can be prepared by treating them with potassium sorbate.

Acknowledgment

Grateful acknowledgment it made to Drs V. Subrahmanyan, Director, A. Sreenivasan, Deputy Director for their interest and encouragement in this work, to Dr G. S. Siddappa for going through the manuscript and to Dr S. S. Kalbag for providing facilities in Technology Block.

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STUDIES ON DEHYDRATION OF SOME TROPICAL FRUITS—PART V. NUTRITIVE VALUE OF PRODUCTS

By H. D. AMIN* AND B. S. BHATIA
(*Central Food Technological Research Institute, Mysore*)

Materials and Methods

Methods of preparation of experimental materials and some of the analytical procedures employed have been described in earlier papers[1-4]. Reducing and total sugars were determined in the alcohol extracts by Lane and Eynon method[5], starch by acid hydrolysis method[6] of A.O.A.C., phosphorus by the method of Fiske and Subba Rao[7] using a Lumetron colorimeter and the 650 mμ filter, calcium by A.O.A.C. method , iron by colorimetric method of Snell and Snell[8], ascorbic acid by the formaldehyde condensation method of Robinson and Stotz[9] and β-carotene by the chromatographic method of the Association of Vitamin Chemists[10] using magnesium oxide and supercell (1:3) in the chromatographic column and 3 per cent acetone in petroleum ether as eluant.

Results and Discussion

TABLE I. *Changes in reducing and total sugars during sulphuring and drying in papaya, pineapple, banana and mango*

Fruit	Treatment	Per cent (moisture-free basis)	
		Reducing sugars	Total sugars
I. Papaya	1. Fresh 2. Sulphured and dried	72.3 67.8	72.8 68.5
II. Pineapple	1. Fresh 2. Sulphured and dried	68.7 53.6	87.0 57 4
III. Banana (*Nanjangud Rasabale*)	1. Fresh 2. Sulphured and dried	33.5 44.5	63.9 62.6
IV. Mango (*Raspuri*)	1. Fresh 2. Sulphured and dried	20.7 20.0	85.5 79.0

TABLE II. *Sugar content of some varieties of banana during different stages of drying*

Variety	Treatment	Moisture %	Per cent (moisture-free basis)	
			Reducing sugars	Total sugars
Kadabale	1. Fresh	70.3	66.8	73.5
	2. Sulphured	68.1	75.9	80.8
	3. Sulphured and dried	18.3	70.5	70.5
Salem	1. Fresh	72.7	58.9	71.7
	2. Sulphured	70.7	70.7	78.5
	3. Sulphured and dried	20.1	70.7	75.1
Chandrabale	1. Fresh	73.8	14.0	70.4
	2. Sulphured	70.7	49·1	77.6
	3. Sulphured and dried	20.4	45.9	61.0
Pachabale	1. Fresh	73.9	32.6	74.0
	2. Sulphured	73.3	30.9	60.3
	3. Sulphured and dried	15.8	65.4	76.6
Nanjangud Rasabale	1. Fresh	71.4	31.4	33·4
	2. Sulphured	68.8	52.0	47.7
	3. Sulphured and dried	17.6	33.0	40.9

Sugars: In Table I are given the reducing and total sugars of the fresh, sulphured and dried papaya, pineapple, banana and mangoes. The results show that there is some loss of sugars on drying, which may be mainly due to the leaching losses during sulphuring. Of the fruits studied only banana showed an increase in reducing sugars after drying, although one would have expected a fall in the sugars due to the oozing out of syrupy liquid during drying. This observation leads to the possible explanation that activation of some enzymes responsible for the increase in sugars may be taking place. To verify this, the sugar content in different varieties of banana was estimated during different stages of drying. The results given in Table II show that the treatments caused some increase in the reducing sugars after sulphuring in most of the banana varieties, the

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* Student of Fruit Technology Associateship Course (1958-60) and now Lecturer at the Agricultural College, Junagadh.

TABLE III. *Changes in sugars and starch content of Chandrabale banana pulp after sulphuring and keeping at 37°C*

	Reducing sugars %	Total sugars %	Starch %
Fresh ...	4.7	18.1	1.25
Sulphured ...	9.4	18.9	0.99
After keeping at 37°C for 1 hr. ...	8.9	18.9	0.57

maximum increase being in *Chandrabale* variety. To collect further information the fruits of the above variety after peeling were blended into pulp which was kept in a closed jar at 37°C for one hour after adding a few drops of toluene. For comparison, pulp obtained from sulphured fruits (15 lb. sulphur/1000 cu. ft./7 tons fruit/2 hours) was also kept likewise. The temperature ranged from 35 to 45°C during sulphuring. Before estimating the sugars, enzymes were inactivated by using hot 80 per cent alcohol[11]. The results given in Table III (averages of 3 estimations) show that the reducing sugars are practically doubled after keeping for 1 hr. at 37°C or after sulphuring for 2 hrs. This may be due to the activity of the enzyme invertase or amylase which are known to be found in fairly large quantities in bananas. According to Von Loesecke[12], there is a spontaneous increase in invertase action of banana extracts on ageing or standing. The present results are in conformity with these observations. McGuire and Falk[13] observed that after the maximum rise, the invertase activity decreased again due to the formation of a new enzyme. The trend of values in our experiments appear to give some support to the above observations.

Minerals: The mineral contents of some of the dehydrated fruits are given in Table IV. Although the data show considerable variation due mainly to sampling errors, it may be concluded that the dehydrated fruits are a fairly rich source of minerals. Cruess[14] has pointed out that the wide range of variation in the values of minerals in dehydrated fruits is mainly attributed to the variations in samples used and to variety, maturity, growing conditions, etc.

TABLE IV. *Mineral content of some dehydrated fruits (moisture-free basis)*

Fruit	Treatment	Calcium (mg %)	Iron (mg %)	Phosphours (mg %)
Pachabale banana ...	1. Fresh	75	1·05	88.0
	2. Sulphured and dried	21	1.45	80.0
Papaya ...	1. Fresh	190	0.08	41.5
	2. Sulphured and dried	210	0.06	50.5
Pineapple ...	1. Fresh	360	...	46.6
	2. Sulphured and dried	570	...	45.3

β-carotene and vitamin C: Data regarding the retention of β-carotene in papaya and mango during sulphuring and drying, shown in Table V, indicate that β-carotene is fairly stable and reasonably well retained. Dehydrated papaya and mango are good sources of β-carotene.

The data regarding the vitamin C contents of the dehydrated banana, cashew apple, pineapple, papaya and mango given in Table VI show that banana is a poor source of vitamin C. The high retention of true ascorbic acid (90.3 per cent) in dehydrated cashew apple shows that it is a good source of vitamin C. In pineapple samples dried after sulphuring, the retention value varies from 64 to 90 per cent as against a value of 36 per cent in the case of sulphited and dried samples, thereby

TABLE V. *Retention of β-carotene in some sulphured and dehydrated fruits (values expressed on moisture-free basis)*

Fruit	Treatment	β-carotene	
		μg/100 g.	% Retention
Papaya 1″ thick slices	1. Fresh	37,070	...
	2. Sulphured	26,920	72.6
	3. Sulphured and dried	26,290	70.6
Mango *Raspuri* (¼″ thick slices)	1. Fresh	29,440	...
	2. Sulphured	22,720	78.0
	3. Sulphured and dried	14,910	50.6
Mango *Badami* (whole slices)	1. Fresh	43,240	...
	2. Sulphured and dried	37,920	87.0
	3. Steam blanched, sulphured and dried	30,920	71.5

TABLE VI. *Retention of ascorbic acid in some dehydrated fruits*

		True ascorbic acid		
		Fresh (mg %)	Dried (mg %)	Reten-tion %
Banana *Pachabale* whole	...	10.4	0.0	0.0
Kadabale whole	...	1.7	0.0	0.0
Cashew apple ¼″ slices	...	859	776	90.3
Pineapple ½″ thick slices	...	22	19.8	90.0
¼″ ,, ,,	...	22	14.2	64.0
⅛″ ,, ,,	...	22	8.0	36.3
Papaya ½″ ,, ,,	...	244	175	71.7
¼″ ,, ,,	...	244	214	88.0
⅛″ ,, ,,	...	244	215	88.0
Raspuri mango 1½ thick slices	...	38	32	84.0

N.B.:—All fruits were sulphured for 2 hrs. @15 lb. sulphur per 1000 cu. ft. space for 7 tons of fruits except in case of ⅛″ thick pineapple slices which were steeped in 0.25% potassium metabisulphite solution for 30 minutes before drying.

showing that sulphiting causes more destruction of ascorbic acid perhaps due to enhanced leaching losses. The retention of ascorbic acid in papaya is from 71.7 to 88 per cent in the three sizes of slices dehydrated. It may, however, be stated that the absolute values of ascorbic acid in dehydrated banana, pineapple and mango are very low and range between 0 and 32 mg. per 100 g. Dried cashew apple is a rich source of vitamin C.

Summary

1. Some of the dehydrated tropical fruits are rich in minerals like calcium, phosphorus and iron and very rich in sugars.

2. β-carotene is fairly stable during sulphuring and dehydration.

3. Sulphiting causes more destruction of ascorbic acid due to leaching losses resulting in a dehydrated product low in ascorbic acid when compared with sulphured fruits.

4. Retention of ascorbic acid during drying is fairly high (64-90 per cent) in dehydrated pineapple, papaya, mango and cashew apple. Considering absolute values, dehydrated cashew apple is the best source of vitamin C (776 mg per cent).

5. Variations in sugars during sulphuring and drying of banana (specially *Chandrabale* variety) are probably due to the action of enzymes like invertase and amylase.

Acknowledgment

Grateful acknowledgement is made to Dr V. Subrahmanyan, Director, Dr A. Sreenivasan, Deputy Director, Dr Girdhari Lal, Assistant Director (since retd.) for their interest in this investigation and to Dr G. S. Siddappa, Assistant Director for going through the manuscript. Thanks are also due to Dr S. S. Kalbag for providing facilities in the technology block.

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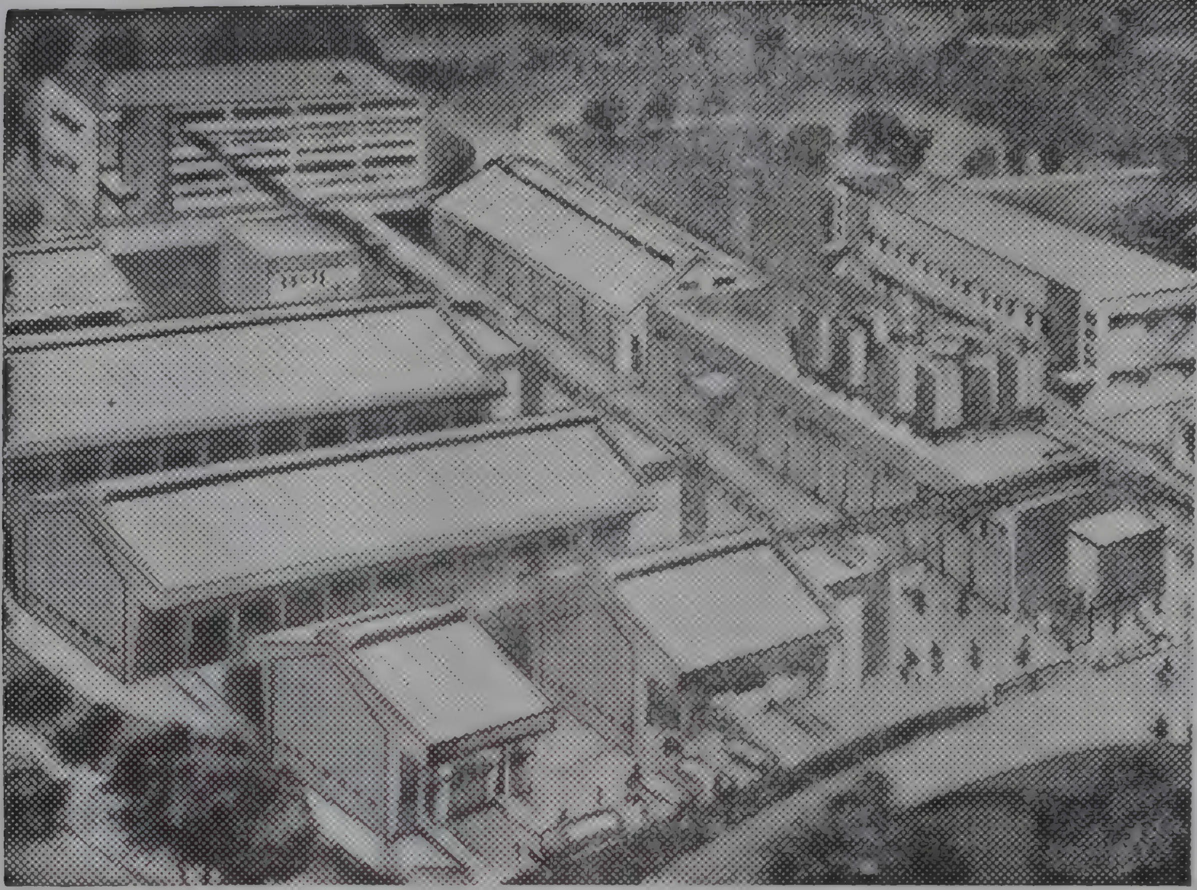

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STUDY OF MICROFLORA OF SOME PROCESSED VEGETABLES

By K. R. Sripathy, T. N. Ramachandra Rao and Dayal Singh Johar

(Central Food Technological Research Institute, Mysore)

The present investigation was undertaken at the instance of the vegetable canning industry, where spoilage had been noticed, particularly in products such as canned peas, cauliflower, cabbage and spinach. Though some attempts have been made by Indian workers recently, it was felt that there was need for collection of more data on the subject of spoilage encountered in canned vegetables under Indian conditions of canning.

A study of the isolation, identification and thermal death time of the spoilage organisms was therefore taken up with a view to be of help to the industry in this field.

Verma *et al*[1] reported that exposure for 30 minutes at 115°C or for 10 minutes at 120°C, was necessary for complete destruction of the spores of heat resistant aerobic bacilli from milk. Iyer and Bhat[2] reported on the thermal resistance of four dominant strains of heat resistant bacilli, commonly encountered in nature. Ayan Dutt and Bose[3, 4] studied the average bacterial load in vegetables at different stages during canning and isolated, the low heat resistant *B. polymyxa* and *B. lentus* from canned peas and cauliflower. Rangaswami and Venkatesan[5, 6] reported on seven bacterial isolates causing spoilage in canned foods. The present studies relate to the spoilage encountered in five types of processed vegetables under Indian conditions.

Materials and Methods

The material for investigation consisted of cans of peas, cauliflower, spinach, potatoes and beans, processed as per the schedule given below for each:

Products	Time (minutes)	Temp. (°F)	Pressure (lbs)
Cauliflower ...	25	240°	10.8
Beans ...	50	240°	10.8
Peas ...	42	240°	10.8
Potatoes ...	42	240°	10.8
Spinach ...	60	250°	15.0

The processed material from industry was recovered and stored for a period of one year at room temperature and samples showing external symptoms of spoilage were taken up for examination. The material was examined according to the method described by Esty and Sternson[7].

Isolation and characterisation of spoilage organism: By employing standard plating techniques, seven pure cultures were isolated from these canned vegetables. These were labelled 1 B, 2 B, 3 B, 4 B, 5 B, 6 B and 7 B. At this stage it was necessary to conduct a preliminary study to determine the oxygen requirements, acid and hydrogen sulphite production, with a view to facilitate the choice of methods for detailed identification. The isolates were grown on the following media:

(1) Dextrose tryptone agar with B.C.P.

(2) Liver broth,

(3) Sulphite agar,

(4) Nutrient agar and broth and incubated at 30°C, 37°C and 55°C for a week. The results showed that there was, under anaerobic conditions, no production of H_2S or change in B.C.P. agar. On the other hand, good growth was seen at 37°C on nutrient agar and broth, thus revealing that all isolates were aerobic. Microscopic examination of the 72-hour old culture showed that there was spore formation in all the cases. From the above preliminary tests it was confirmed that the seven isolates were aerobic spore formers.

Detailed identification of the isolates was carried out according to the method outlined by Smith, Gordon and Clark[8]. The results of the morphological and biochemical tests are recorded in Table I. The isolates thus identified are,

1-B, *Bacillus subtilis*,
2-B, *Bacillus licheniformis*,
3-B, *Bacillus cereus*,
4-B, *B. Cereus var. thuringensis*,
5-B, *B. subtilis var. aterrimus*,
6-B, *B. megaterium*, and
7-B, *B. coagulans*.

TABLE I. *Morphological and biochemical characters of the organisms*

Characteristics	1–B	2–B	3–B	4–B	5–B	6–B	7–B
Vegetative rods	0.7μ × 3.0μ cells single; ends round; no capsules; motile, gram positive, protoplasm not vacuolated	0.7μ × 1.8μ not in chains; gram positive	1.0 × 2.8μ in short chains ends round; gram positive; protoplasm vacuolated when in glucose agar	0.9 × 2.9μ in short chains ends round, motile, gram positive, protoplasm vacuolated	0.8 × 2.4μ not in chains; ends round; no capsule; gram positive	1.2 × 2.0μ single, ends round; motile, gram positive	0.9 × 2.6μ not in chains motile, gram positive
Sporangia	Very little, ends of young sporangia well stained	little, slightly bulging	not swollen	distinct	very little	Not distinctly swollen	Not swollen
Spores	0.6 × 1.2μ oval paracentral thin walled, many in 48 hours	0.6 × 1.2μ paracentral thin walled	0.8 × 1.2μ oval, paracentral thin walled	0.9 × 1.3μ oval, paracentral, some are central, thin walled, many in 24 hours	0.7 × 1.1μ oval, paracentral, thin walled, many in 36 hours	1.1 × 1.6μ oval, paracentral, thin walled, many in 48 hrs.	0.8 × 1.2μ oval, thin walled, subterminal
Colonies	Rough, dull, opaque, spreading yellowish white	Rough, heavy outgrowth, spreading off, white	Large, rough, flat, irregular	Large, rough, flat, irregular, dull white	Rough, opaque, spreading, creamish white	Large, smooth, non-spreading, creamy white	Small, opaque
Nutrient broth	Clear, wrinkled, pellicle at the surface. Good growth in 5% NaCl	Clear, wrinkled surface growth	Uniform turbidity, thin pellicle	Uniform turbidity, thin pellicle	Clear, wrinkled pellicle	Turbidity slight, wrinkled pellicle	...
Glucose nutrient agar slant	Growth same as in nutrient agar	Heavy growth hairy outgrowth from the time of inoculation	Heavier than nutrient agar	Better than nutrient agar slants. Whitish	Better growth than nutrient agar slants, slight black pigment formed	Heavy growth	Soft growth, moist more abundent than nutrient agar
Tyrosine agar slant	...	Good growth	...	...	As in nutrient agar	Slight black pigments	...
Utilization of citrate	...	++	+	++	+	–	–
Hydrolysis of starch	+++	+++	+++	+++	+	+++	+++
Fermentation test	No gas in any of the carbohydrate used. But acid in rafinose, glucose, maltose and lactose	Little gas, acid in glucose, sucrose, mannitol, and slightly in lactose	No gas, acid from glucose, mannitol, sucrose, glycerol, negative in lactose, rhamnose and rafinose	No gas, but acid in glucose, sucrose, glycerol, and mannitol. Negative in lactose, xylose and rhamnose	No gas, acid in glucose, rafinose, glycerol, mannitol, sucrose. Negative in lactose and rhamnose	No gas, acid from glucose, sucrose and mannitol. No acid in lactose, rhamnose and glycerol	No gas, acid from glucose, sucrose, rafinose, mannitol and lactose. Negative in glycerol and rhamnose

TABLE I. *Morphological and biochemical characters of the organisms—(continued)*

Characteristics	1-B	2-B	3-B	4-B	5-B	6-B	7-B
Reduction of nitrate to nitrite	+++	+++	++	+++	+	++	++
Production of acetyl-methyl carbinol	–	+++	++	+++	+	+	++
Hydrolysis of gelatin	++	+++	++	+	++	++	+
Hydrolysis of casein	++	+++	++	+	+	++	+
Any special test	pH of the glucose broth changed to 5.5 from 6.8	Good growth between 45 and 52°C. Max. 58°C. No growth at 28°C	Anærobic gas production from nitrate and growth in glucose broth	Slight growth in 5% NaCl	No anærobic production of gas from nitrate. pH of glucose broth is 6.1	Indole not produced. Methylene blue reduced within 36 hours	Urease not produced. Anærobic gas is produced in glucose broth
Name assigned according to the method of Smith, Gordon and Clark	*B. subtilis*	*B. licheniformis*	*B. cereus*	*B. cereus var thuringiensis*	*B. subtilis var aterrimus*	*B. megaterium*	*B. coagulans*

Thermal resistance of B. licheniformis: Of the seven bacterial isolates, the spoilage organism from peas (*B. licheniformis*) was selected for thermal death time studies, as preliminary data had indicated its greater heat resistant nature as compared with the other isolates.

Potato dextrose agar at pH 6.8 was found to be the best medium and abundant spores were obtained at 48 hours' growth at 37°C.

Thermal death time studies were made according to the method of Bigelow and Esty[9], using pyrex test tubes 10 cm long with an inside diameter of 7 mm and a wall thickness of 1 mm. A spore suspension in sterile phosphate buffer at pH 7.0 was made, and 2 c.c. of the suspension was used. A lag period of 1.5 minutes was allowed as per the method of Townsend[10], for the tubes to attain the desired temperature of the bath which was maintained with a deviation of ± 0.1°C. Five tubes were run in each set and as all the tubes showed positive reaction these were plated out after cooling, in nutrient agar. The record of the count of colonies is given in Table II.

TABLE II

Temperature used	No. of colonies grown on the plate
(*Control:* No heat treatment given)	
80°C	Numerous
90°C	Numerous
100°C	Numerous
105°C	Numerous
110°C	97 colonies
115°C	27 colonies
120°C	No growth

Discussion

Five processed products (peas-*Pisum sativum:* cauliflower: *Brassica oleracea botrytes:* spinach: *Spinacia oleracea:* potatoes: *Solanum tuberosum* and beans: *Phaseolus vulgaris*) which showed signs of spoilage have been examined for the causative organisms. In all cases spoilage was due to bacterial action. The cultures on preliminary examination revealed that they belonged to the aerobic spore forming group. By adopting standard methods and media the morphological and biochemical properties of the isolates have been studied.

The identification of these cultures has been accomplished. The isolates (confirmed by the above identification) are *Bacillus subtilis*, *B. licheniformis*, *B. cereus*, *B. cereus var. thuringiensis*, *B. subtilis var. aterrimus*, *Bacillus megaterium* and *B. coagulans*.

B. licheniformis, isolated from peas, was the most heat resistant organism encountered. As recorded in Table II the destruction temperature lies between 115°C and 120°C for this organism. Further studies regarding the 'F' and 'Z' values are under progress. It is evident, that in low acid vegetable packs, care needs to be taken to guard against aerobic spore forming bacteria especially those which have a tendency to function under low oxygen tension such as *B. licheniformis*, *B. cereus* and *B. coagulans*.

Summary

Five samples of canned vegetables, namely peas, cauliflower, spinach, potatoes and beans which showed signs of microbial spoilage have been examined in detail. The causative bacterial cultures on preliminary examination revealed that they belonged to the aerobic spore-forming group.

The isolates confirmed by identification are: *B. subtilis*, *B. licheniformis*, *B. cereus*, *B. cereus var. thuringiensis*, *B. subtilis var. aterrimus*, *B. megaterium* and *B. coagulans*.

Of all the isolates, *B. licheniformis* appeared to be the most resistant to processing by heat. The heat resistance of the isolate has been studied. This organism was viable even at 115°C for a period of 10 minutes, but was killed at 120°C. This culture was isolated from canned peas.

It is evident that in low acid vegetable packs, aerobic spore forming bacteria have to be guarded against; especially those which have a tendency to function under low oxygen tension, such as *B. licheniformis*.

Acknowledgment

The authors wish to express their thanks to Dr. V. Subrahmanyan, Director and Dr. A. Sreenivasan, Deputy Director of the Institute for their keen interest in the work.

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Technical Seminars

THE Seminar which is a regular scientific activity of the CFTRI provides an open forum for all scientific workers of the Institute in so far as one of them presents a paper on a problem on which he is engaged or reviews an aspect of Food Science and Technology, while others participate in the discussion and express their views on the subject matter of the paper. The visits of distinguished scientists and technologists are also made use of for arranging addresses to such gatherings. Summaries of the Seminars held during September and November 1961 are given in this section.

S (IS) 1

Metabolic interrelationships between vitamin B_{12} and pantothenic acid in the rat, by A. S. Aiyar (*September* 5, 1961).—A functional relationship between the different members of the B group of vitamins may be expected since they serve, in most instances, as components of enzyme systems in intermediary metabolism. Thus, a sparing of the nutritional requirement for individual B vitamins by others in experimental animals, is well documented in literature. Distinguished from these apparently collateral findings, is the reciprocal relationship between vitamin B_{12} and pantothenic acid in the nutrition of several species of animals. An increase in the liver store of either vitamin in a deficiency of the other, has been repeatedly reported in recent years. This inverse relationship between the two vitamins has, however, remained inexplicable hitherto. Since both the vitamins have diverse functions in biochemical processes and particularly in sulfhydryl and methionine metabolism, it was thought of interest to study the metabolism of coenzyme A and related sulfhydryl compounds in the rat, in relation to vitamin B_{12} and pantothenic acid status of the animal, in an attempt to elucidate the mechanism of the enhanced coenzyme A level in vitamin B_{12} deficiency.

Simple vitamin B_{12} deficiency was produced by feeding the weanling rats either a corn-peanut meal ration or a purified casein ration devoid of the vitamin. A double deficiency of both vitamin B_{12} and pantothenic acid was created in one group of rats by dietary omission of both.

The production of a simple vitamin B_{12} deficiency was accompanied by major changes in the sulfhydryl pattern of the liver; while coenzyme A showed a significant increase, both glutathione and the sulfur amino acid, methionine, were lowered. Supplementation of the casein ration with l-cysteine resulted in further increase in coenzyme A in the vitamin B_{12} deficient animal. In the vitamin B_{12} replete group, however, the changes in glutathione and methionine were more marked. Studies on the *in vivo* biosynthesis of coenzyme A and on related changes in glutathione and methionine from intraperitoneally administered l-cysteine and calcium pantothenate showed a greater synthesis of coenzyme A in the deficient group. Administration of vitamin B_{12} to the deficient animals, three hours prior to l-cysteine and calcium pantothenate resulted in a decrease in the synthesis of coenzyme A with concomitant increases in the levels of glutathione and methionine. The changes in coenzyme A and related sulfhydryl compounds in the vitamin B_{12} deficient animal were corrected to a significant extent by 48 hours after administration of a single dose of vitamin B_{12}.

A combined deficiency of both vitamin B_{12} and pantothenic acid resulted in lower liver levels of coenzyme A and glutathione. Administration of l-cysteine alone is without appreciable effect. In marked contrast, prior administration of either vitamin resulted in significant changes; while calcium pantothenate favoured synthesis of coenzyme A, vitamin B_{12} resulted in increases in glutathione and methionine.

Studies with iodoprotein fed rats showed that the rapid depletion of liver stores of vitamin B_{12} is attended by decreases in glutathione and methionine and a two-fold increase in the coenzyme A content of liver. That these changes were due primarily to a deficiency of vitamin B_{12} was shown, by their correction by the administration of vitamin B_{12}.

The results obtained in these studies are indicative of a greater channelling of the sulfhydryl reserves of the cell into coenzyme A rather than into glutathione, in the vitamin B_{12} deficient animal. This is possibly a physiological adaptive mechanism for increased energy production through fatty acid oxidation, to offset the impaired carbohydrate metabolism in vitamin B_{12} deficiency.

During the discussion that followed, questions relating to the high vegetable protein nature of the diet, role of vitamin B_{12} in lipid metabolism, the decrease in acetylating ability in spite of the increase in coenzyme A in thyrotoxicosis, the lipotropic effect of vitamin B_{12} and the source of the extra pantothenic acid stored in the livers of the vitamin B_{12} deficient rats, were asked.

In reply, it was pointed out by the speaker that the corn-peanut meal ration was formulated in this laboratory and was based on a high vegetable protein ration consisting of corn grits and soya bean meal tried elsewhere. The role of vitamin B_{12} in either carbohydrate or lipid metabolism has not been as yet fully ascertained at the cellular level and effects ascribed to this vitamin so far have been based on gross nutritional studies. Recently, reports have appeared implicating, though vaguely, vitamin B_{12} in enzymic systems concerned with carbohydrate metabolism. It is, however, well established that vitamin B_{12} has a lipotropic effect and also that its deficiency causes in some manner a derangement in carbohydrate metabolism. It was also pointed out that there was in effect no discrepancy at all between the increase in coenzyme A and decrease in acetylating ability as determined by the use of model conjugation system, in the thyrotoxic animal since, under the condition of the imposed stress, all the coenzyme A is funnelled into energy yielding processes. A similar situation has been observed by others in the cold exposed rat, where again an increased energy requirement exists. In reply to another question, it was stated that while more of the pantothenic acid available through dietary sources was stored up in the liver as coenzyme A in the vitamin B_{12} deficient animal, in the supplemented animal, more of it was excreted into the urine.

The Chairman, Dr A. Sreenivasan, in his concluding remarks outlined the genesis of the present investigation and supplemented some of the points brought out both in the talk and during the discussion.

S (*IS*) 2

Behaviour of ethylene dibromide and methyl bromide fumigant mixtures on grain and milled material, by M. Muthu (*September* 18, 1961).—Data were presented on the LD 99 for six species of stored-product insects, *viz.*, *Tribolium castaneum*, the red flour beetle, *Calandra oryzae*, rice weevil, *Araecerus fasciculatus*, the coffee bean weevil, *Stegobium paniceum*, the drug store beetle, *Rhizopertha dominica*, the lesser grain borer, *Oryzaephilus surinamensis*, the saw-toothed grain beetle, with the fumigants ethylene dibromide (EDB), methyl bromide (MB) and a 1:1 mixture of EDB-MB with an exposure period of 4 hours at 25°C. The consistent higher toxicity of the mixture over either EDB or MB was pointed out and possible modes of toxic action of EDB and MB were discussed. EDB and MB kill insects without obvious narcotic action, though there seem to be some fundamental differences in their toxic mechanisms. The higher toxicity of the mixture than either of the components is due to possible potentiation involved. As MB is less toxic than EDB, it can be assumed that the potentiation is of this constituent (MB). However, mechanism of the joint action of EDB-MB needs detailed study. It was also stated that the *T. castaneum* females exposed to EDB did not produce normally. Egg maturation and larval development were found to be hindered. The speaker then presented the results on the behaviour of the mixture in grain (jowar).

The concentration-time products expressed as mg. hrs. per litre with 5 to 50 per cent MB in EDB, obtained at the bottom of a 5 feet column showed the superiority of the 1:1 mixture in registering a higher C.T. product than even MB at the same dosage rate of 32 mg/l. In general, all the mixtures were superior to EDB which showed very low C.T. products due to poor penetration. It could be concluded that in all the mixtures where MB was present the propellence of the fumigants was increased resulting in a quicker elution of the EDB component to the bottom levels. This mixture was tried on a large scale for grains at the rate of 2 lb. per 1000 cubic feet. In a rice stack fumigated under a PVC gas-proof sheet even the resistant *Khapra* larvae were killed at all locations of the stack during a 48 hour exposure period which could not be obtained with the same dosage of MB.

Describing the behaviour of the mixture in wheat semolina, the speaker said that the studies were carried out with 1:1, 1:2 and 1:3 mixtures of EDB-MB at there temperatures, *viz.*, 68°, 77° and 100°F at a dosage of 48 mg/l.

The C.T. products at the top were always high in columns. Only the bottom penetration was of more interest. High C.T. products *viz.*, 200 mg. hr /l were obtained with all the mixtures at 68°F. At 77°F and 100°F there was a lowering of the C.T. product with the mixtures, and with MB it was still less. The mortality of the *T. castaneum* adults, however, was widely different at different temperatures. At 68°F both the 1:1 and 1-2 mixtures showed 100 per cent mortality of the insects while 1:3 combination was inferior. At 77°F, 1:2 combination was the best showing nearly 90 per cent mortality during the exposure period. The other mixtures and MB could be placed in the following decreasing order: 1:1, 1:3 and MB alone. At 100°F the mortalities of the insects were very poor, 1:2 being the best followed by 1:1 and 1:3. In general, the 1:2 mixture proved more effective than the other combinations in semolina columns. Increasing the MB proportion to 1:3 and beyond, did not improve the efficiency. A proportion of the EDB component in MB resulted in better maintenance of the intergranular concentrations at all levels. It was interesting to note that EDB penetrated the 5′ column in the 1:2 mixture at 68°F. It was pointed out that on the basis of discrepancies between the C.T. products and insect mortalities obtained at different temperatures with the mixtures, further detailed studies on the mechanism of toxicity were warranted.

In large-scale experiments under gas-proof sheets, the 1:2 mixture @ 2.5 lb/1000 cu. ft. at an elevated temperature of 41°C proved better than MB at 3 lb./1000 cu. ft. on wheat flour stacks. It was observed that with MB the development of high internal pressure and escape through the bottom seals as well as through the fabric were responsible for low concentrations of the gas in the stacks, whereas, with the 1:2

mixture, the higher proportion of EDB helped better retention of the vapours as indicated by the analysis of gas samples by bioassay and chemoassay methods. The samples drawn from the large-scale trials on wheat flour stacks were thoroughly disinfested at all stages of *T. castaneum*, as evidenced by the emergence test on incubation.

Commercial trials with the different proportions of EDB-MB indicated that the 1:1 and 1:2 combinations could cover a wide range of temperature and fumigation conditions such as insect species involved, dockage, stack size and types of grain and milled materials.

Then the speaker dealt with the following protective equipment and application techniques for large-scale use of the Durofume fumigant combination:

(*i*) The improvised inexpensive halide leak detector lamp was exhibited and the performance discussed. (*ii*) A method of reviving old gas mask canister was narrated and its efficiency pointed out. (*iii*) Use of a long non-kinking type of air-hose to replace the canister was suggested. (*iv*) Principles of pressurised packaging of EDB and MB in cylinders were stated. (*v*) A method of using 1 lb. cans of MB in admixture with EDB with a special applicator was demonstrated and the advantages outlined. (*vi*) Field analysis of the fumigants making use of the room temperature dehydro-halogenation with monoethenolamine in glass ampoules in calibrated two-way gas sampling tube was described.

The discussion, that followed, covered the points: (*i*) boiling points of EDB and MB as well as of mixtures; chemical nature of the fumigants and their toxicity, (*ii*) inflation of the cover occurring at high temperatures, (*iii*) whether the proportions of EDB and MB are to be varied at different temperatures, (*iv*) whether Durofume combinations could counteract fungal damage, and if it were so, could it be tried on pepper, (*v*) influence of moisture on fumigant performance, (*vi*) bromide residues with various combinations of EDB and MB, (*vii*) effect of fumigant on germination of seeds, (*viii*) possibility of spray-treating the grain, (*ix*) effective concentration to which insects are exposed, (*x*) suitability of vapourising EDB and (*xi*) feasibility of devising suitable techniques to achieve better distribution of the fumigant.

In reply, Sri S. K. Majumder discussed the points raised in a general way and said that the slope of methyl bromide time-concentration product curve in respect of the bottom sampling point of the column, was a descending type, in contrast with the combinations of EDB-MB. Although MB built up high concentration at the bottom rapidly within 5 hours exposure period, the progressive sorption by the commodity and the reaction with the constituents lowered the initial inter-granular concentration. This is due to the fact that MB in comparison with EDB is more reactive and labile. In combination with ethylene dibromide, the inter-granular C.T. product was kept at higher level than the MB and EDB used singly at the same 32 mg/1 dosage. But, temperature exerted a very critical role on the mixtures at different proportions. At a temperatures of 100°F and above, the insecticidal toxicity decreased with the increased proportions of MB. It indicated that the kinetic and thermodynamic property of gases at temperatures higher than the optimum, tended to reduce the toxicity by lowering the contact period with the substrate in insect on which it was biochemically active. Comparatively, a fumigant with lower vapour pressure within the same series, was more insecticidal. It is probable that MB being soluble in EDB and MB acting as propellant for EDB, the synergistic or joint action was exerted by the tracheal translocation and increase in the retention time on the site or substrate and ultimate manifestation of toxicity. Hydrolysis of MB in the presence of moisture was also inhibited in the presence of EDB as evidenced by the level of residues and inter-granular concentrations.

He stated that the superiority of the mixtures of EDB-MB was due to the required vapour pressure, and some physical properties such as compatibility, mutual solubility, probable azeotropic behaviour, optimum diffusability and penetrability in grain bulk, low sorption, low rate of hydrolytic reaction with moisture and other desirable operational features. He added that the physical constants for the systems would be determined in collaboration with the National Physical Laboratory, New Delhi.

Dealing with the problem of residue, Sri Majumder presented the data on the residues of MB, EDB and of mixtures on different commodities. He emphasised that on the basis of the concentration of the fumigants, lowest residues and minimum effect on viability were obtained with mixtures. The combinations were both insecticidal and fungicidal. But higher dosages such as 6 lb/1000 cu. ft. and above, were required for grain sterilization.

Referring to the possibilities of distributing EDB in bags in stacks and disinfestation of grain, flowing on conveyors, it was mentioned that EDB could diffuse in grain about 1 metre distance from the point of introduction and emphasised the need for mechanical distribution in all the geometrical aspects of the bag stack. The propellance of MB and its use as a carrier gas for EDB were satisfactory for effective distribution in all locales of stacks treated *in situ*. Varying the proportions of the components and dosages, several commodities can be fumigated. Treatment of grains in a processing equipment, has some possibilities in mechanised harvesting and threshing, but a pre-harvest prophylactic treatment on the ripe grain panicle with permissible concentration of pesticides having low mammalian toxicity offer more promise for field disinfestation under present circumstances in the production centres.

Further, he dealt with the problem of scaling up of laboratory results in small fumatoria such as desiccators or autoclaves to the bulk disinfestation under warehouse conditions. He emphasised the importance of studying the behaviour of fumigant mixture with load and without load in small fumatoria, tall fumigation columns and gas-proof sheets in warehouses, as the minimum lethal dosages under laboratory conditions in desiccators and stacks in warehouse conditions, vary widely.

The President, in his concluding remarks stressed the desirability of determining the optimum concentrations at which mortality would take place and suggested that improved methods should be evolved to ensure a more uniform distribution of the fumigants for thorough disinfestation at all locales thus achieving the economic utilization of the fumigants.

S (*IS*) 3

An investigation into productivity measurement in pineapple processing industry, by A. V. Venkatesan, (*September* 25, 1961).—The objective of the study was defined as help the industry at its present technical level by examining the practices in vogue and suggesting ways and means of improving the efficiency of production, reducing the wastage and thus decreasing the cost of production. In order to attain the objective, the scope of study was limited to: examining the existing practices and working out their efficiency by proper allocation of work with a unit operation and co-ordination with the other; man-machine relationship and examining the line of production and working out proper workloads for each operation, finding out the major bottlenecks and obstructions in production, reducing the wastage of material, time and labour, suggesting alternate practical methods to improve efficiency.

The production system for the purpose of this study was divided into the following units of operation: receiving the fruit and stacking; cutting the crowns and ends; slicing the fruit; peeling; punching; coring; trimming; washing and filling of cans; weighing; vacuumising; syruping; exhausting; seaming; processing; cooling and storing (stacking).

The speaker described the present practices highlighting the bottlenecks; delays, wastages and idle time of the machine and men in the present production system. He then stated the method of setting up standards and how the standards were computed and allocation of work made for each unit operation, as also how the capacity of machines measured to cope up with the production programming. Having obtained the workload standards, he then detailed how indicators of the missing information on wastage and returns of the production statistics were obtained by processing five experimental lots of fruits of different sizes and collecting information on (*i*) juice spilling (*ii*) crowns and ends (*iii*) peels (*iv*) cores and pomace and (*v*) breakdown of the product through the production system at its different stages. The speaker then described how the efficiency of the existing system as also the efficiency the projected altered system might obtain, were measured. He then summarised the findings as follows: (*i*) The ordering of fruit for processing is not co-ordinated with production leading to lean and glut periods, in the former slow and inefficient working, in the latter spoilage and wastage due to stacking. (*ii*) The method of slice collection leads to accumulation at the mechine, the slices as they are fed from the slicer to the peeling table are in such a manner that the slices cut earlier are not removed for longer time. The delivery of slices at peeling tables, the punch at coring tables and cored at trimming tables and trimmed at storage point near washing tables are such as to disturb the worker from the unit operation. This is done in two ways either by the roving worker who brings or removes the material or by the movement of the worker doing a unit job to another type of work. (*iii*) The number of points of wastage collection method of removal and the number of workers engaged on it, affects work, hinders work and is not very efficient. (*iv*) A number of workers are required to do more than one job, such as punching or coring and removal of product and waste. The other type of differentiation which affects productivity is when a puncher and corer has to select the size of the slice or punch or core. (*v*) The tables now being used are not conducive to efficient working nor is the present flow of production from one unit operation to another.

The speaker concluded with suggestions for the introduction of: (*i*) revolving table near slicer for arrangement of slice collection from slicer in order to be delivered to the next zone in sequential order, (*ii*) peeling, punching and coring tables of recommended design which have facility to meet all the drawbacks of the existing system, (*iii*) trolleys for carrying waste and finished product, (*iv*) realignment of production sites in factory layout situating the peeling and decrowning zone outside the processing hall, (*v*) work load assignments at each individual operations and exaction of norm in day to day production. (*vi*) gradual sloping of floor of the factory wherever steps are located to facilitate easy movement of men and machine.

Sri A. Rahman traced the genesis of the study and gave an account of the stages involved in operational research which is always a collaborative effort involving various disciplines with the statistician playing a central role.

Sri H. C. Bhatnagar said that the report was a comprehensive one and the study, though revealed certain salient features of the production system, related to the cost of labour which formed 6 per cent of the total production cost. He laid emphasis on the horticultural aspects of pineapple in relation to processing and added that if the size of the fruit and the period of maturation could be standardized, many of the existing problems in pineapple processing would be automatically simplified.

The discussion that followed brought out several aspects of the research programme: Desirability of sending a team of engineers and economists before a statistician takes up the evaluation work; need for improvising the process under the existing conditions by technologists rather than an engineer or a statistician; evaluating efficiency in terms of unit of production instead of unit of operation; possibility of developing other products from pineapple wastes; whether the results obtained in this study had general applicability; whether in the recommendations suggested, any provision was made for carrying over the surplus fruit without spoilage; the working conditions as obtained in the factory probably might not permit the maximum efficiency of labour; the whole layout of the factory might need some drastic changes.

Sri K. C. George (pineapple grower from Trichur) who was present at the Seminar, generally agreed with the recommendations made on the basis of the work conducted at Trichur and mentioned a few of the improvements that he himself had effected in the pineapple processing. He also said that some of the designs for coring and peeling machinery for pineapple would be made available for developmental work. He was of the opinion that, in addition to the canning of pineapple, any study that might lead to the prolongation of the keeping quality of the fresh fruits would be of great economic value as the fresh fruit could fetch very good returns particularly in the north Indian markets and the other areas far removed from the growing region. He pointed out further that the main snag was the rotting of the core and suggested that the Institute might take up this work.

The President in his concluding remarks said that the points raised were already thought of and that the study had a restricted bearing which was also fairly recognised. Though efforts on this type should relate to the industry as a whole, this study was taken up as an indicator to possibilities of further work in this direction. As regards the preservation of the pineapple core, he said that it ought to be taken up. He further said that systematic mechanisation should be aimed at bringing down the cost of pineapple processing at various levels of production. He emphasised the need for working a model factory on the lines of the sago factory as it would be a logical approach to the implementation of the improvements suggested. In studies of this type, it is likely that relevant data pertaining to costs of certain items might not be forthcoming in which case, the research worker might make efforts to compute approximate cost to enhance the value of the study.

S (*IS*) 4

Further studies on the influence of proteins and amino acids on blood sugar and glucose tolerance, by J. Meena Rao, (*October* 7, 1961.)—At the outset the speaker gave a brief account of the present knowledge concerning the physiological and biochemical disturbances in diabetes. He also traced the genesis of the present investigations to certain observations regarding the influence of casein and certain legume proteins on the glucose tolerance of diabetic and normal subjects which had been discussed in two previous seminars. Following up these observations the influence of hydrolysed proteins on the fasting blood sugar levels and glucose tolerance of diabetic and normal subjects was investigated. It was expected that pre-digestion would help to bring into the blood stream amino acids or peptides in sufficiently high concentration so that the effects of the proteins could be enhanced. However, the results obtained with a diabetic subject and two normal subjects with a papain hydrolysate of casein showed very clearly that the hydrolysate exerted an effect comparable with that of the original protein but was no better.

The speaker then presented the experimental results obtained with normal as well as diabetic subjects bearing on the influence of the ingestion of mixtures of glycogenic and non-glycogenic amino acids in the amounts equivalent to that present in 30 g. casein. The effect of these mixtures of amino acids was comparatively low.

In view of the rather special position of leucine which has been reported to produce severe hypoglycemia in cases of familial hypoglycemia and also in experimental animals at high doses, the effect of this amino acid on the oral glucose tolerance in diabetic subjects and on oral and intravenous glucose tolerance in normal subjects was investigated. The results obtained indicated clearly that in the diabetic leucine, as contrasted with the cases of familial hypoglycemia, exerted absolutely no effect either on the fasting blood sugar or glucose tolerance. In normal individuals, however, the effect of leucine on glucose tolerance varied from individual to individual, though in all cases a definite effect on the peak and post prandial levels of blood sugar was evident. It was also observed that in some individuals the response varied from time to time.

With a view to elucidating possible mode of action of proteins and also leucine on glucose tolerance, the possible influence of ingested protein on insulin action was studied in both diabetic and normal subjects, by administering suitable doses of insulin both subcutaneously and intravenously at definite time intervals after the ingestion of casein or leucine. The results clearly revealed that neither protein nor leucine either prolonged or potentiated the action of insulin.

With a view to ascertaining the causes for the relatively low postprandial levels of blood sugar produced by protein or leucine in the course of the glucose tolerance studies, the possible inhibitory effect of ingested protein or leucine on adrenaline action was investigated. The harmone was administered subcutaneously half-an-hour after the ingestion of protein or leucine and the effects on the adrenaline hyperglycemia examined. The results clearly demonstrated that in the two normal individuals studied, only leucine was found to exert an inhibitory effect on the hormone.

The speaker also presented certain experimental data relating to the influence of various doses of leucine on liver and muscle glycogen deposition in the fasted rat. The results indicated that leucine even at high levels did not influence the deposition of glycogen in either of these tissues.

The speaker then presented some preliminary observations made on three diabetics, past the middle age, relating to the possible long term influence of supplementing their daily diet with 20-25 g. of protein in the form of casein or skim milk protein. In all the three cases the prolonged supplementation of the protein seemed to influence markedly the glucose tolerance curve, as well as the fasting blood sugar levels. The speaker, however, emphasised that before drawing any conclusions regarding the influence of protein supplementation of the diet on the fasting blood sugar level, glucose tolerance and insulin requirements of diabetic subjects, more carefully controlled chemical trials were needed. The speaker concluded by stating that in addition to the clinical trials, animal experiments were in progress to ascertain the influence of the quality and quantity of dietary protein on the pancreas with special reference to the function of the beta-cells and the influence of protein and amino acid on insulin secretion as measured by plasma insulin activity.

Following up the speaker's presentation, Dr M. Srinivasan pointed out that in all these studies human volunteers had been used as the guinea-pigs which imposed certain limitations on the number and type of experiments. He particularly pointed out that a large number of tests had to be carried out on one individual to get definite results and each sitting involved five or more bleedings. He, therefore, pleaded for additional facilities for experimenting with dogs, the best animals to use in such studies and for further intensification of the clinical trials on larger well-controlled groups of cases.

In the course of the discussions several important points were raised, *e.g.* how long blood sugar would persist at the low levels in the postprandial period; whether there was any information on the incidence of diabetes in populations which normally consumed high protein diets; whether the pattern of amino acids in the blood had been studied after the ingestion of protein; whether leucine was present in high concentration during the period of digestion and absorption; whether plasma insulin estimations had been done after ingesting protein or leucine; whether the acid hydrolysate of casein fortified with cysteine had been tried; the effect of feeding zinc and zinc salts on the blood sugar level and glucose tolerance in view of the fact that insulin is present in the pancreas as a zinc complex; the influence of proteins on fat metabolism, ketone bodies and cholesterol level in blood in the diabetic; whether the effect of proteins was related to their specific dynamic action; the influence of cystine on blood sugar levels and glucose tolerance since it is known to be rapidly incorporated into insulin and also whether leucine acts similarly by getting incorporated into insulin and thereby increasing the synthesis and secretion of the latter.

In answering these questions, the speaker mentioned that in certain previous studies quoted by Dr Allen there was some evidence that the incidence of diabetes was lower in population groups taking high protein diets but so ar as India was concerned there were no accurate statistical data available. The possible effects of ingestion of protein and leucine at different levels on the secretion of insulin would be revealed by the results of the experiments now planned using the rat diaphragm technique to study the plasma insulin activity after the ingestion of various proteins and amino acids. The effects on fat metabolism and ketone bodies have to be studied in the long term tests and most of the experimental subjects presently investigated were early diabetics who did not show any ketone urea. Once there is improvement in carbohydrate utilization one can expect the disturbance in fat metabolism also to be rectified.

Supplementing the speaker's answers, Mr M. V. L. Rao pointed out that in the normal course of glucose tolerance curves, the blood sugar level usually goes slightly below the original starting levels within about half an hour after it attains the peak and then returns to the basal level in the course of the next half an hour. In this rapid restoration of blood levels, adrenaline plays the major part. It was for this reason that the possible inhibitory effects of ingested proteins and leucine on adrenaline action were examined. As for the effects of zinc and zinc salts, the immediate effects on glucose tolerance and blood sugar levels have to be ascertained. The zinc in the pancreas only helps to store the insulin as an insulin-zinc complex. In recent years there have been some reports from Dr Schqartz's laboratory that certain fractions of casein improve glucose tolerance in experimental animals. These fractions which contain chromium and chromium salts have been shown to have some influence on glucose tolerance in these animals. The possible relation between the effects of protein on glucose tolerance and their specific dynamic action have to be further investigated. Presumably the influence on carbohydrate metabolism may be one of the mechanisms by which the specific dynamic action is exerted.

In his concluding remarks, the President stressed the difficulties involved in having to confine the work to human subjects and the consequent slow progress. He suggested that if some other index than the effect on glucose tolerance could be made use of for measuring the effects of proteins and amino acids on carbohydrate utilization, it may help in accelerating the progress of the work. He also emphasised the need for more intensive animal experiments to elucidate the mechanisms of action of proteins and amino acids on carbohydrate utilization. He also mentioned that the effects of proteins on fat and phosphorus metabolism should also be simultaneously investigated.

S (*IS*) 5

Studies on the dehydration of tapioca, by S. Kuppuswamy (*October* 23, 1961).—The work on the dehydration of tapioca was started following the observation that carefully prepared tapioca flour with good keeping quality can be used as a substitute for corn flour, wheat flour, rice flour and pulse flours in many food preparations. Among the tubers, tapioca is characterised by its extreme perishability, being highly susceptible to fungus attack and become unfit for consumption in 2-3 days after harvest. Though several methods of chemical preservation of tapioca have been worked out, the method of choice would be by drying because, the most important use for tapioca as food is in the form of an attractive and stable white flour. In Kerala, which is the foremost tapioca-producing State in India, nearly 60 per cent of the tapioca is sun-dried. According to the traditional method the tuber is cut into thick slices after the removal of the outer skin but not necessarily the inner rind, spread on the floor and allowed to dry in the sun. The chief drawbacks of this method are: (1) easy contamination with dust and other extraneous matter, (2) presence of the inner rind rich in the cyanogenetic glucoside and (3) slow rate of drying, especially under unfavourable weather conditions, facilitating incipient fermentation. The remedies that suggest themselves to overcome these drawbacks are: (*i*) use of trays or barbecues or concrete flooring with high walls, (*ii*) complete removal of the inner rind prior to slicing and (*iii*) cutting the peeled tuber into thin slices and using a chemical preservative to check the fermentation during drying. Among a number of preservatives tried, sodium hypochlorite was preferred in large scale trials in view of its cheapness. Under ideal conditions for sun-drying, it was found that tapioca slices can be dried in the course of two days provided the slice thickness of 3/16″ and trayload of 1.25 lb./sq. ft. are not exceeded. Although the main crop of tapioca harvested during the months of December to March can be conveniently sun-dried in Kerala State, the second crop harvested during the monsoon months, will have to be processed exclusively by artificial dehydration. Both in through-flow drier and cross-flow drier, drying temperatures greater than 70°C were found to give rise to scorching in the dried product, but the drying time can be reduced appreciably, especially in the case of the cross-flow drier, by adopting phased drying, wherein the product is dried to about half the period at 80°C followed by a finishing temperature of 70°C. The optimal trayload is 16 lb./sq. ft. in the case of the through-flow drier and 1.25 lb./sq. ft. in the case of the cross-flow drier; however, under the same conditions of temperature and slice thickness, the drying time of the excessively higher trayload in the through-flow drier is less than half that of the trayload in the cross-flow drier, bringing out the superiority of the through-flow drier for tapioca dehydration. The optimal thickness was found to be 1/4″ in the case of the through-flow drier and 3/8″ in the case of the cross-flow drier.

The problem of the cyanogenetic glucoside in the tapioca tuber is important in the context of the residual hydrocyanic acid content of the tapioca flour. The hydrocyanic acid content of the edible portion of several Kerala varieties of tapioca ranged from 17 parts per million to 424 p.p.m. on the dry weight basis. There was a loss of 5-15 per cent of the hydrocyanic acid on overnight soaking in sodium hypochlorite solution and 50-75 per cent on drying, the loss during sun-drying being slightly higher than during dehydration. Among the varieties studied only *Wynaad Vellai*, *Thota Kappa* and *Malai Vellam* were suitable for the purposes of processing into edible tapioca flour, taking the standards laid down by the Central Committee for Food Standards as the criteria.

In respect of the storage studies, the speaker said that tapioca flour prepared either by sun-drying or dehydration keeps well for 6 months at room temperature in ordinary gunny bags, alkathene-lined gunny bags, cloth bags or cans, provided the tubers are processed within a day of harvest. If, however, there is a delay of 3 days before the material is dried, its keeping quality is adversely affected as shown by organoleptic evaluation and reflected in the rapid increase in the water soluble acidity and is not improved by soaking the slices in sodium hypochlorite solution prior to drying. Tapioca flour stored at an initial moisture content of 6.7 per cent picks up about 5 per cent moisture during storage for 6 months in gunny bags or cloth bags and this can be limited to 1-2 per cent by using alkathene-lined gunny bags.

Describing the pilot plant trial recently carried out on the dehydration of 5 tons of tapioca in the tunnel drier, the speaker stressed the need for a suitable labour saving device for the peeling of tapioca because it takes 15-16 people working for 8 hours to peel one ton and added that the percentage of spoiled tubers unfit for processing progressively increases with the time after harvest. The cost of production of tapioca flour on the basis of a unit producing 1500 tons of flour annually works out to 59 naye paise per kilogram, assuming the price of raw tapioca to be Rs 70 per ton.

Supplementing the talk, Dr D. S. Bhatia pointed out that the success of the project would depend to a large extent on the rapidity with which tapioca is dried following harvest. He added that from the point of view of consumer acceptability, it is not desirable to steep the slices in any preservative prior to drying and emphasized that the economic feasibility of the project can be fully assessed only by carrying out a number of drying runs in the centres of production.

During the course of the discussion questions asked were: reasons for the rapid spoilage in the tapioca tuber following harvest; the costing structures on the basis of smaller and still larger units; the development of water-soluble acidity in tapioca flour during storage and its control by removing the free sugars with glucose oxidase; relationship between the stage of harvest and the hydrocyanic acid content of tapioca; tapioca detoxicated by blanching; the most economical method of heating in the dehydration of tapioca.

Answering the questions, the speaker said that the rot in tapioca is due to a fungus of the *Rhizopus* species while the development of acidity is due to an unidentified bacterium. While treatment with glucose oxidase is a well-known commercial practice in the case of the dehydration of costly materials like eggs and pork, it will be far too expensive in the case of a cheap and bulky material like tapioca. The stage of harvest will have a profound influence on the hydrocyanic acid content, but if the harvesting is delayed too long, the flour may become unattractive on the score of high fibre and ash contents. Blanching is out of question because it will gelatinise the starch and tapioca soji and not flour will result. While the most economical method of heating in dehydration will be by steam, indirect heating with wood, dried skins and rind, etc., should also prove feasible.

In his concluding remarks, the President pointed out that the problem of rapid spoilage in tapioca has been confronting the scientists for a long time and is worthy of a thorough study. The problem of hydrocyanic acid need not be a deterrant to the consumption of tapioca flour, because, as has been shown in the case of the Burma bean, the hydrocyanic acid is almost completely removed as a result of the moist heat treatment to which the flour is subjected in the preparation of various dishes. The high cost of tapioca also need not worry us because at the time of the main harvest, it is quite low and a sizable surplus will be available for processing. He forecast a bright future for the processing of tapioca into edible flour and agreed with the suggestion of Dr D. S. Bhatia that the dehydration process needs to be demonstrated to the growers at the centres of production.

S (*IS*) 6

Studies on the types of spoilage in Indian canned fruits and vegetables, by Mr. Mirle S. Subba Rao (*October* 30, 1961).—India produced 32,000 tons of canned fruit and vegetable products valued at Rs 388 lakhs in 1957 and exported nearly 1,700 tons. Some of the products have already found good market abroad and favourable market can be created for canned fruits like mangoes, guavas, litchies and mandarin type of oranges.

The fruit and vegetable preservation industry in India is at present utilizing hardly 0.12 per cent of the fresh fruits and vegetables produced in the country. Approximately 15-20 per cent of this produce goes waste on account of inadequate facilities for transport and processing. Preservation or processing of even half of this quantity going to waste at present, would increase the production by 80-100 folds. These factors suggest that there is a strong case for the development of fruit and vegetable preservation in our country.

The speaker said that a large number of the existing processing factories are either small or of medium size and lack the services of trained personnel necessary for maintaining a uniform quality of the products. The present work was undertaken to help the industry in detecting the types of spoilage in fruits and vegetable products and to suggest the remedial measures.

Samples of spoiled canned fruits and vegetable products were obtained from the industry. The samples analysed were (*i*) fruits belonging to 14 varieties—28 and (*ii*) vegetables belonging to 17 varieties—48. The analysis included the examination of the can, degree of corrosion, appearance of the contents, percentage of salt and acid, pH of the material and microbiological examination. The standard media used were: dextrose-typtone broth and liver broth in the case of canned vegetables; proteose peptone yeast extract agar, malt extract broth, tomato dextrose broth and acid meat medium in the case of fruits. The media inoculated with vegetables were incubated at 37° and 55°C. Proteose peptone yeast extract agar media inoculated with fruits was incubated at 55°C, while the other media inoculated with fruits was incubated at 30°C. The results indicated that from among the spoiled cans of vegetables, 14.56 per cent of spoilage was due to heat resistant microorganisms. These microorganisms were present in peas, potato and paprika in brine and vegetable *pulao*. The organisms were isolated and identified to be *Bacillus subtilis* and *Bacillus firmus*. 10.1 per cent of spoilage in case of fruit, and 25 per cent of spoilage in the case of vegetables were due to autosterilization. These samples had all the appearance of spoilage but viable cells were absent. This type of spoilage is attributed to underprocessing or post-processing infection. In the case of canned fruits, there was no spoilage due to infection from cooling water, while in the case of vegetables, the spoilage from this source was 47.95 per cent. The high incidence of spoilage from this type is due to the use of highly contaminated cooling water. This type of spoilage can be minimised by keeping the microbial load to the minimum in the cooling water. From among the hard swelled cans of fruits, 89.3 per cent of the spoilage was due to hydrogen swell. Though the product in these cases is wholesome, it lacks consumer appeal. By a thorough exhaust, not only air is removed but also a good vacuum is maintained in the can. The storage temperature should also be low. By taking these precautions, the incidence of spoilage of this type can be minimised. The springer or flipper due to overfilling or under-exhausting was noticed in 12.5 per cent of the cans examined. Even here, the food is wholesome, but lacks consumer acceptance. By keeping a careful check over the filling and thoroughly exhausting the cans, the springer can be avoided.

In conclusion, the speaker said that the overall spoilage is 0.9 per cent in the case of canned fruits and 0.5 per cent in the canned vegetables. In the case of the vegetables, 0.072 per cent of spoilage is due to heat resistant organism, 0.21 per cent is due to infection from cooling water, 0.12 per cent is due to auto-sterilization and 0.06 per due to overfilling and under-exhausting. In the case of fruits 0.092 per cent is due to auto-sterilization and 0.81 per cent is due to hydrogen swell.

The questions asked during the discussion were: whether the date of manufacture of the cans analysed in the present experiments was the same; in view of some work of this nature having already been done the tin content of the spoiled cans was worthy of investigation; whether the spore count in sugar has been taken into consideration in formulating ISI standards; the concentration of salt in brine in the samples analysed by the speaker appeared to be low; the significance of the variation in the ranges of the chemical constituents and how these results obtained would help the industry; in the case of canned foods, a reorientation of processing may be necessary and may require the follow up of the bacterial count from beginning till the end of processing of the products; whether the thermal death time of the cultures has been done; whether there was any reference in literature to the incidence of *Cl. botulinum* in vegetables; caution had to be taken in reducing the processing time since there is possibility of hazards from *Cl. botulinum* in low acid foods; the processing given for fruits and vegetables was more than adequate at present in the industry; whether any analysis was done of curried samples and whether the *B. subtilis* culture isolated was different from those normally found in the atmosphere with regard to their heat resistance character; there is scope for reorientation of the processing time in fruits without any hazard of spoilage; how cooling water brings about the spoilage and the possibility of using plastic containers; use of lacquered cans for fruits and also the use of electrolytic tin plate; whether the change in colour to brown in peas following processing is due to bacteria; whether there was any correlation between the nature of the product and the spoilage pattern and the seat of infection in the raw material.

Answering the questions, the speaker said that the previous history of the cans used in the present study was not known. The number of samples analysed by the previous workers as reported in the literature was also too small. Based on the report of the present studies, suitable suggestions have been given to the concerned manufacturers to overcome the defects. The thermal death time studies of the two cultures were done; the Z value for *B. subtilis* is 13.5 while that for *B. firmus* is 12.5. Caution has to be taken regarding the reorientation in the processing time in vegetables. The source of spoilage is not due to under-processing as the materials are over-processed in the industry but it is due to a post-processing infection. The culture of *B. subtilis* appeared to be just a normal atmospheric contaminant. Replacement of plastic container in place of metal container has to be examined. The slight defect in the lacquering of can would peel off the lacquer and increase the corrosion. The pattern of spoilage in the case of fruits was predominantly hydrogen swell while in vegetables it was due to infection from cooling water and auto-sterilization.

Concluding the discussion, the President said that since the number of samples analysed was small, it would not give a correct picture of the nature of spoilage; and, moreover, they covered a range of categories of products. Perhaps it will be useful to conduct an intensive study on the given categories of products which show best promise. At present, the industry is over-processing the product to avoid spoilage and this has resulted in the poor quality of the product. He, therefore, observed that studies should be aimed at minimising the infection from the initial stage itself, since sugar and salt may be the source of infection, analysis of these materials is desirable. He mentioned that the follow-up of the bacterial count of the fruits and vegetables till they are finally processed is also necessary. The possibility of pre-washing of the fruits and vegetables in suitable chemicals to reduce the microbial load was also suggested. Once the microbial load is reduced, the final processing would be short which will result in producing a quality canned product and would have consumer acceptance.

S (IS) 7

Studies on FAO reference protein pattern, by Dr M. Narayana Rao, (*November* 6, 1961).—The speaker first referred to some aspects of the newer knowledge of protein nutrition and then dealt with the genesis of the 'FAO reference protein pattern'. He later discussed the results of investigations carried out on the nutritive value of protein blends similar in composition to the reference protein pattern.

Observations both on the protein efficiency ratio and biological value of a protein, which are quantitative measures of its nutritive value, show that both are primarily an estimate of how closely the amino acid composition of the protein conforms to a pattern of amino acids utilized most efficiently by the body. The standard of reference should be a food protein of high nutritional value which is almost completely utilised by the body. The proteins of human milk and whole egg have been suggested as suitable reference patterns for comparing the relative quality of dietary proteins by some workers. Recent investigations carried out by Bender have shown that egg proteins contain an excess of the essential amino acids and as such the chemical scores of proteins obtained by using egg protein as the reference standard would be underestimates.

The FAO committee on protein requirements was of the view that the quality of a protein or diet can justifiably be evaluated by comparing the pattern of essential amino acids with a standard pattern based on a knowledge of the requirements of the essential amino acids by healthy human beings. They took for consideration the amino acid requirements of infants as obtained by Holt *et al.*, of men as obtained by Rose and of women as obtained by Laeverton *et al.* From these patterns of the amino acid requirements, taking tryptophan as unity, the FAO committee arrived at a pattern which is the same in the case of some essential amino acids and the averages in the case of others. The amino acid composition of the provisional protein was obtained by multiplying the above figures by 1.4 so as to equalise its tryptophan content with that present in cow's milk.

A comparison of the essential amino acid content per 16 g. nitrogen of the provisional protein, cows' milk, human milk and egg proteins revealed that the provisional protein contained less of all the essential amino acids as compared to those present in human milk and egg proteins. The chemical scores of different proteins obtained, taking egg, human milk and the reference proteins as standards revealed that the biological values for human subjects of food proteins having lysine as the limiting amino acid are far lower than the scores obtained using the reference protein as the standard, indicating thereby that the reference protein pattern does not contain adequate amounts of lysine.

The protein efficiency ratios of the blends of different foods simulating the amino acid composition of the reference protein as determined by the rat growth method were found to be significantly lower than those of skim milk powder and also of casein. The speaker discussed these results in the light of the data available in the literature, especially that of Scrimshaw and co-workers who have also shown that reference protein contains disproportionately large amounts of methionine in comparison with lysine and other essential amino acids present in it.

Supplementing the talk, Dr M. Swaminathan said that the FAO committee has made a number of approximations in arriving at the reference protein pattern. Available evidence would indicate that the pattern of amino acid requirements of infants is different from that of adults. He added that there is a need in the light of available data on the subject to increase the lysine content of the reference protein to the level present in human milk proteins. The amount of threonine present in the reference protein may also have to be increased to the same level as that present in human milk.

During the discussion questions asked covered: the reason for the difference between the amino acid requirements of men and women; whether in arriving at protein scores, the availability of the amino acids in the food protein need not be taken into account and whether the amino acids of gelatin promote a better growth than the intact protein; requirements of amino acids under conditions of stress; whether the vitamin requirements were completely satisfied in the determination of amino acid requirements; whether the results obtained in the metabolism studies in children on corn diets supplemented with the different amino acids will be different if the order in which the amino acids were supplemented, was changed; whether the proteins of human tissue can be taken as the reference standard.

Answering the questions, the speaker said that the difference in the amino acid requirements of men and women may, to a certain extent, be due to the fact that several groups of workers who have determined the amino acid requirements, differed in their interpretation of what constituted nitrogen equilibrium. The protein scores of food proteins, certainly, depend on the availability of the amino acids in the proteins, but it has been found that the amino acids in most of the proteins, are available to the extent of 90-95 per cent. Human tissue protein cannot be taken as a reference standard because some of the amino acids like methionine, tryptophan and phenylalanine are also required for purposes other than tissue synthesis, with the result that their requirements will be higher than the amounts present in human tissue.

In his concluding remarks, the President emphasized the importance of investigations bearing on practical nutrition and drew attention to the necessity for carrying out studies with the actual diets consumed in different regions.

S (*IS*) 8

Commercial utilisation of solvent extracted groundnut flour, by K. G. Ramaswamy, L. S. Subba Rao and Y. K. Raghunatha Rao, (*November* 18, 1961).—Mr. L. S. Subba Rao described the method adopted for the preparation of groundnut flour. The flour was prepared by flaking clean groundnut kernels and by continuous percolation of the flakes with n-hexane in a stationary extractor followed by desolventisation of the meal by indirect low pressure-steam in a vacuum drier and separating the cuticles by sieving the powdered coarse meal through a 100 mesh screen. The flour obtained contained 54-58 per cent of protein, 2.5 per cent of fibre, 4 per cent of ash, 1 per cent of oil, 11.5 per cent of sugars and 6 per cent moisture. The flour was white and soft and had the flavour of groundnut.

Mr. K. G. Ramaswamy then stated that traditional common foods e.g., cakes, savouries and sweets, were prepared using this flour, which were declared as acceptable by the members of the staff. Flakes were prepared using this flour in combination with fruit pulps such as guava, sapota and mango. Biscuits were also prepared from the solvent extracted groundnut flour in local bakeries according to their formulae and some experiments were carried out at the Institute using the baking oven. The flour was also tried as a component of cheap industrial glue in the local plywood factory and was found to be suitable.

From the flour protein rich material was obtained by the standard peptisation method using the centrifuge as well as vibratory sieves of 150 mesh. In the latter case, the yield of protein rich material was 50 per cent of the flour and the material contained 88 per cent of protein and 0.4 per cent of oil. This material was also tried in making glue.

The flour which was packed in ordinary cellophane bags and in 28 lb. tins, has kept well for over a year.

Mr. Y. K. Raghunatha Rao who supplemented the talk, mentioned that the joint FAO and WHO Expert Committee on Nutrition has suggested that studies should be carried out on flours from ground nuts, cottonseed, sesame, coconut, soyabean and fish and said that the work carried out in the Institute showed that it is feasible to introduce the groundnut flour as a protein-rich supplement in the Indian dietary.

The discussion that followed covered the following points: suitability of the flour for making standard biscuits, the purpose of flaking in the extraction, solvet recovery, economics of the product, yield of protein and its purity, the biological value of the protein, comparison of yields from centrifuging and sieving, the advantages of pre-pressing and solvent extraction *versus* direct extraction, desolventisation temperature, determination of solvent residues, quality of oil, etc.

Sri Raghunatha Rao answering these questions made the following observations: A few samples of biscuits were made in the experimental baking oven at the Institute. Flaking is the usual pre-treatment for solvent extraction whereby material surface is increased thus enabling rapid extraction and preventing fines in the miscella. The solvent recovery data is characteristic of each set of equipment and is furnished by the machinery manufacturers along with the specific design. Data on economics can be studied with large scale trials which have yet to be tried. The yield of protein rich material (88 per cent protein) ranged from 40-50 per cent of the solvent recovered flour. Biological value of the protein of the flour has not been done. It has been shown in USA that centrifuging gives high yield and sieving simplifies the equipment requirements. Direct extraction is now gaining popularity in USA and the present study indicates the possibilities of the process. Filtration extraction is achieved by a newly devised equipment which extracts material beds of comparatively small thickness while the percolation extraction technique used in the study can deal with greater material bed thickness. The optimum plant capacity for solvent extraction may vary from 2 to 100 tons per day depending upon various factors such as availability of raw materials, labour, capital, services etc. The time schedule for completing dry protein recovery was three hours. The moisture content of the flaked groundnut kernels was 6 per cent. The desolventisation temperature was 105-130°C with steam pressure rising to 20-25 p.s.i.g. The oil recovered by the solvent extraction requires stripping which need not involve high temperatures but otherwise the quality of the oil is satisfactory. The moisture content of the protein sludge in the protein recovery was 63-71 per cent while the yield of the protein rich material was 50 per cent of the flour. Estimation of the solvent in traces is done by the chromatographic and ultraviolet techniques. The pH of the dispersion was 12 and no development of smell resulted as $CaSO_4$ was used.

The President in his concluding remarks said that the subject was important and much more work remained to be done.

S (*IS*) 9

Some technological aspects in the preparation of pectin from papaya by the integrated process, by G. S. Siddappa and G. V. Krishna Murthy (*November* 24, 1961).—Introducing the subject, Dr G, S, Siddappa briefly referred to the work done and highlighted certain points which are of considerable significance in scaling up the process for the preparation of papain and pectin from papaya by the integrated process. There are certain technological problems in the process which require careful investigation, particularly in view of the forthcoming pilot plant scale trials of these products from a five acre papaya plantation (8-9 kg. of papain and nearly 3 tons of papaya fruit, yielding about 30 kg. of pectin, are expected from 200 plants in one tapping season).

Speaking nextly, Mr Krishnamurthy said that the yield and quality of pectin depend upon several factors such as: (*a*) preliminary treatment of the raw material, (*b*) nature of extraction, (*c*) method of precipitation and (*d*) degree of purification. Pectin prepared from the fresh unpeeled papaya fruit is white in colour, while that prepared from the dried unpeeled fruit is of light brown colour. It is, therefore, necessary to peel the fruit, if they are to be dried for subsequent extraction of pectin. Mechanical peeling of the fruit is rather a difficult problem on account of the irregular shape of the fruit. Hand peeling which involves a considerable amount of labour, is rather expensive. It is, however, possible to remove nearly 70-75 per cent of the peel, using a potato peeler having a revolving emery wheel. The loss in peeling by this method is 7-8 per cent as against 15-16 per cent by hand peeling. Rasping of the pulp to about 30 mesh size facilitates the removal of non-pectin water-soluble matter and also helps in better extraction, than either cutting the fruit into slices of about 1/20″ thick or mincing it to 16-18 mesh size. The loss of pectin is considerably more during blanching than in steeping of the slices in cold water. The drying rates of the blanched and water steeped material are practically the same in truck drying, the drying time being nearly 8 hrs. In the sun, under optimum conditions (40-60 per cent R.H. and 30-37°C), the material dried in 7-9 hrs. Rotary drying and truck drying give dried products which are superior to the sun dried product in regard to the quality of pectin. The optimum ratio of pulp to extracting acid is about 1:7 in the case of the fresh, rasped and pressed material and 1:40 in the case of dried material.

Separation and purification of the aluminium pectinate are critical steps in the process. Dewatering of the pectinate curd has to be done without subjecting it to any vigorous mechanical agitation such as in a vibrating sieve or a high speed centrifuge because it is likely to lose its texture and pass on to the effluent liquid. For large scale handling of this material, a slow moving 'reel' is to be preferred. Such reels are employed widely in industry. Purification of the pectinate has to be carried out under rigorously controlled conditions of pH, acid and alcohol concentrations, in order to get a product of superior quality.

The yield and quality of pectin are greatly affected when the mother liquor is allowed to stand for long periods, due to fermentation. It is, therefore, necessary to handle it without much delay. The stability of the pectin is dependant to a large extent on the pH of the final product.

Seeds, spent pulp and the peel (when the fruit is hand peeled) are the important by-products in the process. The seeds which constitute about 4 per cent of the weight of the fruit, can be utilised for the preparation of certain pharmaceutical products based on their medicinal properties. The spent dry pulp contains about 6 per cent protein and 88 per cent crude fibre and may be useful as a cattle food.

Supplementing the talk, Sri B. H. Krishna, mentioned that the results reported had been arrived at after a series of experimental trials. It may, however, be necessary to modify some of the steps for scaling up the process for large scale production.

The discussion covered the following points: the effect of varieties of papayas on the quality of pectin, no systematic work has been done on except for honey dew, Gujerat etc., as seedless varieties have not so far been developed to such an extent, it is not possible at present to prepare pectin from thereon on a large scale. Previous work has already indicated that papain and pectin contents will be at their maximum when the fruit is about 3 months old from the date of setting. It is not desirable to have lye peeling of papayas as pectin is highly sensitive even to the cold dilute alkalis. The drying of the aluminium pectinate with a view to reducing the alcohol requirements during washing, use of flocculents for the precipitation of aluminium pectinate; repeated extraction with the same liquid; drum drying of pectin solution, etc., had already been tried, but were not quite satisfactory. Suggestions were also made to explore the medicinal uses of seeds, recovery of alcohol at a distillery; use of acetone for the precipitation of pectin; preparation of papaya beverages.

The President, in his concluding remarks, emphasised the need for developing a method for the recovery of papain from the peel and also other parts of the plant. He also pointed out the importance of the removal of chlorophyll during the process. The papaya seeds, being an important by-product, ways and means should be found out for their economic utilization such as in pharmaceutical preparations, etc. The lanced papaya fruit, if allowed to ripen, is not likely to find out other probable outlets for the fruit in addition to pectin and some preserved products. It may be possible to utilize the green papaya fruit as a vegetable also. He pointed out the necessity for a detailed biochemical study with particular reference to the milk clotting and proteolytic fractions of papain.

Information and Advice

IN pursuance of the policy of rendering technical aid to food industries in the country, the CFTRI supplies information on technical and other problems, carries out analytical work and undertakes short- and long-term investigations on behalf of the industry, besides bringing out publications containing important technical advances in different aspects of Food Science and Technology. The Institute deals with a number of enquiries from various food industries and others interested in Indian processed food products. A few of the enquiries answered are reproduced in this section.

E (*IS*) 1

Baker's and medicinal yeasts

Baker's yeast is being manufactured by M/s. Indian Yeast Co. Ltd., Bhadtakali, their present installed capacity per annum being 800 tons on wet basis or 300 tons on dry basis.

The total capacity under implementation for the production of medicinal yeast is 268 on dry basis. The firms entrusted are: M/s R. G. Murmuria, Calcutta; M/s. Dyer Meakin Breweries, Lucknow and Salahabad; M/s. Alembic Chemicals, Baroda and M/s. Ruthanjee and Co., Calcutta.

(*Development Wing, Ministry of Commerce and Industry*)

E (*IS*) 2

Sweetening agents

1.	Sugar ...	1
2.	1-Methoxy-2 amino-4 nitrobenzene ...	450
3.	Saccharine ...	500
4.	5-Benzyl-2 furfuraldoxine	690
5.	Mixture of saccharin and dolein (p-ethoxyphenylusec) ...	770
6.	1-Ethoxy-2 amino-4 nitrobenzene ...	830
7.	Nitro-amino-phenylether	1000
8.	1-Propoxy-2 amino-4 nitrobenzene ...	3100
9.	Propoxyniltrainline ...	4100

However, the practical use of these compounds is not feasible owing to their powerful antiseptic properties.

E (*IS*) 3

Chutneys in polyethylene

Polyethylene containers are not suitable for packing and storage of chutneys and pickles containing vinegar and/or oil for the following reasons:

(*i*) They contaminate the product with external odours —being neither odour-proof nor gas-proof.

(*ii*) They are permeable to vinegar.

(*iii*) Rancidity is developed in the oil pickles.

However addition of spices helps improve the preservation of the product.

E (*IS*) 4

Amino acid composition of cashewnut proteins

(Average protein content-21.2 per cent)

Arginine ...	10.3
Histidine ...	1.8
Lysine ...	3.3
Tyrosine ...	3.2
Phenylalanine ...	4.4
Cystine ...	1.0
Metheonine ...	1.3
Threonine ...	2.8
Valine ...	4.5

E (*IS*) 5

Dehydration of peas

The pods are removed from the vines and fresh pea grains obtained with the help of viners. These are then size-graded and washed in cold water, when the floating peas are removed and rejected.

Uniformly size-grade fresh peas are blanched in boiling water for 1-2 minutes, followed by thorough cooling and inspection. These are then load on to the drying trays at the rate of 1 lb. per sq. ft. of the tray area.

Dehydration is economical in thermal driers both of the parallel flow and counter current types. Other adjustments required are:

		Hot end	*Cold end*
Parallel Flow	Dry Bulb	180°F	168°F
	Wet Bulb	...	110°F
Counter Current	Dry Bulb	150°F	
	Wet Bulb	...	100°F

The peas are dried to a moisture content of 5 per cent. The yield of dried peas is 9-14 per cent.

E (*IS*) 6

Equipment suppliers

Driers (Different types)

(*i*) M/s. Armstrong Smith Private Ltd., Gresham Assurance House, P.B. No. 185, Fort, Bombay-1.

(*ii*) M/s. Kilburn & Co., Private Ltd., Gresham Assurance House, Fort, Bombay-1.

(*iii*) M/s. Garlic & Co., Private Ltd., Hains Road, Bombay-11.

Roasters

M/s. Bharat Electric Service Co., Sri Narasimharaja Road, Bangalore-2.

Grinders

M/s. National India Engineering Co., Botawala, Nicol Building, 7/10, Elphinston Circle, Bombay-1.

E (*IS*) 7

Preparation of spice oils

A flavouring extract is defined as a solution in ethyl alcohol of proper strength of the sapid and odourous principles, derived from an aromatic plant or parts of the plant with or without its colouring matter conforming, in name, to the plant used in its preparation.

The principal method of preparation is that of distillation and another important method is that of solvent extraction.

Steam distillation. Most of the essential oils are obtained by this method. A current of steam is passed through the product which is heated in a still. The oil is vapourized and is led through a condenser along with the steam. Both oil and water are condensed and the condensate is caught in receivers known as 'florentine' flasks which act as separating devices to separate oils lighter and heavier than water from the aqueous phase. To overcome low yields, the aqueous portion is often returned to the still and the mixture is redistilled.

Alcohol distillation. This process is adopted for the preparation of terpeneless essential oils. One volume of the oil is distilled with 5 volumes of 83 proof alcohol. A distillate is obtained in which the essential oil is soluble but in which terpenes are relatively insoluble. The alcoholic phase is returned to the still and the mixture is redistilled in order to eliminate most of the terpenes.

Fractional distillation. This is usually performed under reduced pressure and is used particularly for the manufacture of terpeneless and sesquiterpeneless oils. The first cut or portion of distillate consists principally of the terpenes; the middle cut or fraction usually comprises the oxygenated compounds which form the desired portion of the oil; the third fraction consists of the sesquiterpene and the less desirable portions of the original oil. This process is generally performed on an oil obtained by one of the other methods mentioned.

Solvent extraction. Low boiling solvents such as ethyl alcohol, methyl alcohol, acetone, chloroform, ether, petroleum benzine and other solvents are employed to extract the oil by percolation or by maceration. The essential oil is then recovered by distilling off the solvent.

This essential oil is then shaken out with a given solvent such as an aqueous alcohol mixture of definite composition which gives the maximum extraction of the oxygenated components with the minimum solution of the terpenes.

E (*IS*) 8

Composition of bajra

Moisture	12.4 %
Protein	11.6 %
Fat (ether extractives)	5.0 %
Mineral matter	2.7 %
Fibre	1.2 %
Carbohydrates	67.1 %
Calcium	0.05 %
Phosphorus	0.35 %
Iron	8.8 mg. %
Calorific value	360/100 g.
Carotene	220 I.U. of Vit.A/100g.
Vitamin B_1	330 g./100g.
Nicotinic acid	3.2 mg./100g.

E (*IS*) 9

Sweet pickled cucumber

Cut the cucumbers lengthwise down the centre and carefully remove the seeds. Cut into 1 in. length. Do not peel. Place in a basin and cover with salt. If a large quantity is being made, sprinkle salt between each layer. Leave with a cover over the basin for 2-3 days, stirring once or twice. Drain off the liquid and rinse away some of the salt. Dissolve 3/4 lb. sugar in each pint of medium-hot spiced vinegar and stew the cucumber gently in the sweetened vinegar until the skin is soft. Take out the pieces and pack neatly into pickle jars, using not more than 4 chillies as a garnish to each 10 oz. jar. A very attractive bottle can be arranged with little trouble. Boil the remaining syrup until thick, then pour into the jars so that the cucumbers are covered by at least 1/2 in. of vinegar. Cover (covers should be vinegar proof and reasonably air tight) the jars and store in a cool, dark and dry place.

E (*IS*) 10

Cucumber and onion pickle

Recipe: 2 lb. cucumber
1 lb. small white onions
1½ pt. spiced vinegar

Method: Cut the cucumber into slices about 1/2 in. thick and quarter them. Peel the onions and slice them finely. Mix the two together in a deep basin and cover with salt. Soak in brine for 24 hours, then drain well. Pack into jars and cover with unspiced vinegar for 24 hours, then drain and cover with spiced vinegar. Tie down well and allow to mature before using.

E (*IS*) 11

Spiced vinegar pickle

Recipes: To one quart of vinegar:

Mild spice

¼ oz. cinnamon
¼ oz. cloves
¼ oz. mace
¼ oz. allspice
a few peppercorns

Hot spice

1 oz. mustard seed
¼ oz. chillies
1 oz. allspice
½ oz. cloves
½ oz. black peppercorns

Medium spice

½ oz. cloves
½ oz. allspice
½ oz. cinnamon
½ oz. ginger
½ oz. white peppercorns

Aromatic spice

½ oz. allspice
½ oz. coriander
¼ oz. cardamom
¼ oz. cinnamon
12 cloves
6 bay leaves

Method I: Steep the whole spices in the vinegar in closed bottles for 2-3 months. Shake occasionally. Before use, allow to stand undisturbed for 2-3 days and then decant carefully, straining through a fine cloth.

Method II: Heat the vinegar and whole spices together to boiling point. Cover with a lid and allow to infuse for 2-3 hours. Strain well through a fine cloth.

E (*IS*) 12

Dill pickles

These are fermented pickles made at a higher salt concentration.

A barrel is filled with freshly washed green cucumbers, 10-12 lb.

of cured dill weed, 1 quart of whole spices, one quart of 100 grain vinegar, and a brine containing from 8.4 to 8.5 per cent (32-36 Salometer) salt. One pound of garlic buds may be added in some cases. Onions, horse-radish, grape leaves etc., are also added to improve the flavour. However the addition of these materials hasten the chances of spoilage of the product and should therefore be avoided.

These pickles undergo a primary lactic fermentation in which the acidity increases very rapidly during the first week, and a secondary fermentation, in which the production of acid is more gradual. The finished pickles should contain 3.5 to 4.5 per cent slat and 1.0 to 1.5 per cent acid, expressed as lactic. Temperature plays an important part in these type of pickles fermentation and the ideal temperature is 60-70°F. At higher temperatures, during fermentation, the loss of flavour and acid are noticed and create high pressure, due to the evolution of gases which helps to blow the head or bung or to burst the staves.

The pickles are then desalted and placed directly into jars or 45 allon barrels and hot brine containing the requisite amount of soluble spices, salt and distilled vinegar added.

Adding the spices to the jars directly is preferable since the loss by evaporation is minimum and more uniform spicing is obtained.

Dill pickles under normal conditions are cured and are ready for use within a period of about 2 months.

1962 BABCOCK-HART AWARD

Dr V. Subrahmanyan, Director, Central Food Technological Research Institute, Mysore, has been honoured with the distinction of being the recipient of the **Babcock-Hart Award for 1962** for his contributions in the field of Food Science and Technology which have directly resulted in improved public health through some aspects of improved nutrition or more nutritious foods.

The Babcock-Hart Award is donated by the Nutrition Foundation Inc., and is administered by the Institute of Food Technologists, Chicago, U.S.A. It carries an honorarium of $ 1,000 with an engrossed plaque. The adjudication for this Award is done (on the recommendations of some senior members of the Institute of Food Technologists) by a Jury of leading Scientists appointed by the Professional Society of Food Technologists.

Dr Emil M. Mrak, Chancellor of the University of California, Davis Campus, was the recipient of the Babcock-Hart Award for the year 1961. This is the first time that such a distinction has been conferred on an Indian and the first non-American citizen.

Dr Calvert L. Willey, Executive Secretary of the Institute of Food Technologists, has requested Dr V. Subrahmanyan to attend the *1962 IFT Annual Meeting Awards Banquet* scheduled for 12th June, 1962, at Miami Beach, Hotel Fontainebleau, California, U.S.A., and accept the Award in person. Dr V. Subrahmanyan will deliver an *acceptance speech* on the occasion.

Notes and News

Census of Indian Manufactures—Food Processing Industries

Industry	Number of Factories		Productive Capital		Total No. of workers employed	Wages Salaries and non-cash benefits (Rs. Lakhs)	Gross ex-factory value of production (Rs. Lakhs)	Total value of inputs (Rs. Lakhs)	Value added by manufacture (Rs. Lakhs)
	Registered	Covered	Fixed (Rs. Lakhs)	Working (Rs. Lakhs)					
1957									
Wheat flour ...	86	78	347	364	7,719	99	4,249	3,936	313
Rice milling ...	1,760	1,567	732	1,411	65,518	292	10,214	9,599	615
Biscuit making ...	93	81	277	145	5,669	71	726	529	197
Fruit and vegetable processing ...	32	27	59	62	1,766	16	171	128	43
Sugar ...	187	181	4,610	8,016	1,39,950	1,303	13,907	10,362	3,545
Distilleries and breweries ...	50	50	221	197	5,215	60	492	281	211
Starch ...	12	10	148	214	1,857	26	498	401	97
Vegetable oils:									
(*a*) Excluding hydrogenated oils ...	1,134	946	1,180	1725	46,107	305	13,350	12,776	574
(*b*) Edible hydrogenated oils ...	30	30	556	804	8,542	163	6,047	5,578	469
1958									
Wheat flour ...	90	76	348	355	7,483	99	4,155	3,824	331
Rice milling ...	1,744	1,452	714	1,190	57,831	247	7,972	7,524	448
Biscuit making ...	92	76	204	136	5,261	78	742	518	224
Fruit and vegetable processing ...	29	21	38	58	1,573	13	144	107	37
Sugar ...	198	168	4,372	5,918	1,25,511	1,243	12,970	9,355	3,615
Distilleries and breweries	49	41	198	166	4,608	65	466	288	178
Starch ...	9	7	1,167	249	2,048	28	494	401	93
Vegetable oils:									
(*a*) Excluding hydrogenated oils ...	1,153	830	999	1,423	37,708	257	10,589	9,896	693
(*b*) Edible hydrogenated oils ...	29	23	499	769	7,107	153	5,600	5,101	499

(**Source:** *Monthly Abstract of Statistics*, 1961, **14** (1), 70)

C.F.T.R.I. NEWS

The following special seminars were arranged:

1. Dr E. C. Bate-Smith, Director, Low Temperature Station, Cambridge, England on 29-11-61.
2. Dr M. Autret, Director, Nutrition Division, Food and Agriculture Organization of the United Nations, Rome on 11-12-61.
3. Dr Sam C. Smith, Secretary, Williams-Waterman Fund Research Corporation, New York, U.S.A. on 11-12-61.
4. Dr S. S. De, Senior Regional Nutrition Officer, Food and Agriculture Organization of the United Nations, Bangkok on 11-12-61.
5. Dr W. H. Sebrell (Jr), Director, Institute of Nutrition Sciences, Columbia University, New York, on 23-1-62.
6. Dr G. N. Irvine, Assistant Director, Grain Research Laboratory, Board of Grain Commissioners for Canada, Winnipeg, Canada on 30-1-62.

NEWS BRIEFS

Cheesemaking mechanized: C.S.I.R.O. in Australia is developing machines to do away with the laborious task of making cheddar cheese by hand.

Following the successful operation of a pilot plant in the Dairy Research Section, Highett, Victoria, the first commercial milling, salting, and hooping machine was installed and went into use at the Kraft Foods Factory at Allansford, Victoria, in April.

The machine has proved capable of handling up to about 8000 lb. of curd per hour, which is well above the output of even the largest factories. As well as cutting manufacturing costs considerably, it makes the cheesemaker's job a much more pleasant one. Only three men are needed, whereas upto eight are required for the conventional process. The whole operation is continuous and the machine has brought cheddar cheese-making into line with modern concepts of food processing and handling.

The machine has three main components. A milling unit slices blocks of cheddard curd into small strips, which are conveyed to a unit that adds salt and mixes it with the cheese in a rotating drum. The salted curd then falls into rectangular hoops. When the required amount has been delivered, a photo-electric control stops the discharge, and the line of hoops is moved to bring an empty one into position.

The salt is added to the curd evenly and accurately by means of a novel electronically controlled device that measures salt into the mixing drum in proportion to the amount being handled. It is expected that this device will find ready application in other industrial processes.

Although well adapted to deal with curd produced in the traditional way, the milling, salting, and hooping units were originally designed to deal with curd from a curd-fusion (cheddaring) machine in a fully mechanized operation. A prototype cheddaring machine was described in 'Rural Research' 21; a commercial version is now being designed and should be ready for production during this year. (*Food Technol. Austr.*, September 1961, p. 491).

Pesticide residues in meat: The inspection authorities in the United States are carrying out routine testing of home produced and imported meats for the possible presence of chlorinated organic pesticide residues. Minute quantities of these residues are permitted to be present in meat in some cases but in others no tolerance whatever is allowed.

Such chemicals are absorbed into the body tissues and accumulate in the fat, therefore the effect of continuous dipping or spraying of the animals themselves, or the spraying of pastures, with the compounds concerned could lead to the finding, on analysis, of traces in the fat from the resultant meat.

Both Canada and U.S.A. have prescribed tolerances for certain chlorinated hydrocarbon residues in meat, *e.g.*, D.D.T., Lindane (gamma isomer of B.H.C. only), Malathion, Toxaphene.

There is a nil tolerance for B.H.C., therefore any trace whatever of this chemical in any consignment will involve the risk of total rejection by the North American authorities. (*Food Technol. Austr.*, September 1961, p. 513).

Bitterness in orange juice and rootstock: Mr J. F. Kefford and Dr B. V. Chandler (C.S.I.R.O., Division of Food Preservation) made a study of the effects of rootstock on the composition of Washington Navel oranges grown on eight rootstocks and Valencia Late oranges grown on three rootstocks in several regions during six seasons. Trifoliate orange and rough lemon exerted contrasting influence on orange composition, while sweet orange occupied an intermediate position. The effects of rootstock were similar on both scion varieties but were more marked with Washington Navel oranges.

Trifoliate orange stock tended to give high yields of juice which was high in acidity and soluble solids content but low in ascorbic acid content and in bitter taste when canned. Rough lemon stock tended to give low yields of juice which was low in acidity and soluble solids contents but high in ascorbic acid content and in bitter taste.

A positive correlation was demonstrated between the bitter taste of canned juices and the concentrations of limonoid bitter principles in the peel of Washington Navel oranges, and in the peel and seeds of Valencia Late oranges.

Trifoliate orange stock promoted the disappearance of bitter principles from all parts of the fruit with advancing maturity, but rough lemon stock retarded this process. (*Food Technol. Austr.*, September, 1961, p. 515).

New dehydration equipment for army food research: The Australian Army has imported an Accelerated Freeze-dryer, a type of dehydration equipment; for experiments in combat food research for use at the Army's food research station at Scottsdale in Tasmania.

The unit, worth about £9,000, has been developed by the British Ministry of Agriculture, Fisheries and Food and built by the Vickers-Armstrongs engineering works.

It provides a new method of food dehydration and food dehydrated by this method reconstitutes almost immediately when water is added to give a product almost indistinguishable from fresh food.

At Scottsdale, various types of meat and fish will be dehydrated in experiments to produce a suitable ration pack for combat conditions. The Army hopes that use of food so treated could reduce, and in some instances eliminate, the need for refrigeration in forward areas.

Experiments at Scottsdale aim at producing the most palatable, nutritious and easily handled alternative to fresh food for troops in forward areas. (*Food Technol. Austr.*, November 1961, p. 607).

Vacuum method of preserving fish: A technologist of Hamburg has announced the development of a new method of preserving fish abroad vessels.

The method would entail the storage of freshly caught fish in airtight tanks. The air would then be evacuated from the tanks and the temperature reduced quickly to about 2°F below the freezing point in a vacuum. This process would not only remove gases from the body of the fish but also, through the evaporation of moisture, would freeze the surface of the fish to prevent it from drying out and to keep it fresh. In the absence of oxygen, the development of aerobic bacteria would be virtually eliminated.

The cost of a vacuum plant would be very high, but a trawler thus equipped would save the cost of ice and possibly improve the value of its catch by as much as 10 per cent (says a U.S.A. Bremen Consulate report).

The Federal Fisheries Research Institute of Hamburg has tested the new preservation method in a shore installation with very good results. It has recommended experimental installation of such a vacuum plant on a commercial trawler or on a fisheries research vessel. (*Food Technol. Austr.*, November 1961, p. 609).

Citrus coloured in Queensland: Among the provisions of new food and drug regulations gazetted in Queensland, permission is given for the artificial colouring of citrus fruits. This was approved by the Government in compliance with the request of growers, with a view to the promotion of sales.

The Minister for Health (Dr Noble) said that in the dye colours permitted to be used there were no health dangers. Because of Queensland's climate, he said, citrus fruits, especially oranges, tended to be green in appearance, even when ripe, and did not appeal to consumers as readily as they might with better colouring. In other parts of the world, particularly America, a similar problem was experienced, and artificial colouring of the fruit was permitted. (*Food Technol. Austr.*, November 1961, p. 614).

I.S.O. Sub-committee for spices and condiments meets in New Delhi: The meeting of the International Standards Organization Sub-committee for spices and condiments was held in February 1961 at New Delhi. Delegates from France, Hungary, India, Netherlands, Turkey, U.K. and U.S.A. attended the meeting.

The committee discussed quality specifications in respect of pepper (black and white), ginger, cardamom and curry powder together with the terminology and methods of test with a view to establishing an agreed procedure by which consignments of produce should be sampled and quality assessed. (*Food Technol. Austr.*, November 1961, p. 625).

Vitamins and minerals—New N.S.W. regulations: Regulations were recently gazetted in New South Wales concerning the addition of vitamins to foods. These amendments were:

1. Prohibit the addition of vitamins to any article of food except as permitted by the regulations.
2. Prohibit the use of such claims as vitamin enriched or vitamin fortified implying that the food contains added vitamins.
3. Prohibit the comparison in any advertisement or label of one food with another to indicate the vitamin content.

The F.T.A. of N.S.W. has prepared a detailed submission for representation to the Minister for Health, the Hon. W. F. Sheahan, followed by a deputation to the Minister. The only satisfactory result was that implementation would not take place until the expiration of six months from promulgation, during which time manufacturers have the opportunity of preparing their case for submission to the Pure Foods Advisory Committee for exemption from the new provisions.

The Department has indicated that they would be prepared to receive the one application for exemption for foodstuffs that fall into the same category, which will obviate the necessity of individual manufacturer applications. (*Food Technol. Austr.*, November 1961, p. 635).

Moisture analyzer: The Boonton Polytechnic Co., Inc., believes that its new moisture analyzer is the only meter of its type producing the results desired by processors of chemicals, foods, plastics, pharmaceuticals, paper, packaging, and agricultural materials. A high degree of accuracy in many foods including cereals is assured by the manufacturer. The entire range of moisture is stated to be 0 to 0.04 per cent, necessitating an extreme sensitivity. The test requires 5 minutes, enabling 48 test samples to be run through in 2½ hours; the equivalent amount of tests by the oven weight loss method would have required 5 hours per test or a total of 240 hours. (*Cereal Sci. Today*, November 1961, p. 306).

Bread fermentation flavour: VICO 400, a natural fermentation flavour for use in baked goods, has been accepted by the FDA as an optional ingredient in standardized bakery products at levels up to 2 parts by weight of flour used. This announcement by Vico Products Co. states further that the flavouring is now available in two types, with or without dough-softening effect; it may be used in yeast-leavened baked goods to intensify and balance natural fermentation flavour. They also report, from field evaluations, that its use has resulted in improved tenderness and mouth feel; masking of objectionable flavours attributed to high levels of mold and rope inhibitors; better dough-handling properties; and protection against abuse through thawing and refreezing of products. Ask for Technical Bulletin No. 400-3, giving suggested use levels in English muffins, crumpets, dinner rolls, brown-and-serve rolls, white bread (continuous process), speciality breads, frozen dough, French crescents, butter gems, and high-shortening products. (*Cereal Sci. Today*, November 1961, p. 307).

Cheese whey to livestock feed: A new procedure for converting the solids and dissolved sugars in cheese whey into a high-protein livestock feed has been proposed by Lorne A. Campbell, biochemist at Ontario Research Foundation.

Whey is 95 per cent water and therefore cannot economically be hauled to a central station for processing to recover the lactose and albumin residues in it. The practice of discharging the material without processing causes stream pollution problems since the whey has a very high biological oxygen demand.

The proposed solution to this dilemma is to make use of the fact that yeast Candida pseudotropicalis can be grown on whey, thereby converting its sugar to a protein concentrate. If the whey is then heated, the lactalbumin content will precipitate out, and this, together with the yeast can be removed by filtration. When dried, the solid material would contain about 60 per cent protein and would be rich in nutritional supplements such as phosphate and B vitamins —an ideal livestock feed. (*Cereal Sci. Today*, September 1961, p. 242).

Automation of Kjeldahl analysis: A new continuous digester system, recently demonstrated by Technicon Controls, Inc., Chauncey, N. Y., reportedly provides a degree of reliability and reproducibility unobtainable by prevailing manual methods.

One operator supervising two machines can produce 320 analyses per day using this one-step uninterrupted technique. Precision of results is 2-3 per cent compared with 10-20 per cent normally achieved manually.

Along with increasing work output, the Technicon method is also supposed to substantially reduce equipment and breakage costs. Space needed for the system can be as small as a 3 by 6 ft. area.

An automatic sample changer starts the sample on its trip through the Technicon operation. Sample and digestion reagent (typically, 50 per cent sulfuric acid containing perchloric acid and selenium dioxide) are fed into the digester by a metering pump. Oxidation takes place when they pass through a high heat stage (450°C) and is completed in a second, lower temperature stage (350°C).

An aspirating pipette continuously draws off an aliquot of each sample at the exit end for further processing in the Technicon Auto Analyzer system. Excess material goes to waste. The Auto Analyzer mixes the aliquoted sample with the right amounts of reagents with the help of another multistream metering pump. Next the sample goes through a colorimeter, whose permanently recorded reading is directly proportional to liberated ammonia. (*Cereal Sci. Today*, September 1961, p. 242).

Tapioca food starch: Described as a modified, stabilized starch, Purity 69 is said to be able to withstand 21 or more freeze-thaw cycles without liquid separation or change in texture. Applications are suggested in baby foods, cream fillings, fruit pie fillings, and frozen sauces, gravies, soups, and oriental foods. Cook-ups are said to be clear, smooth, and short textured, exceptionally stable, and do not set to a jel. Technical service bulletins on this product are available from National Starch and Chemical Co. (Canada) Ltd., 371 Wallace Ave., Toronto 9, Ont. (*Canad. Fd. Ind.*, September 1961, p. 60).

Portioning machine: Automatic filling, weighing, and check-weighing of food products during canning or cartoning can be accomplished by this machine. It is known as the Model VEK, and will pack such products as meatballs, fish fillets, chops, shrimps, and many vegetables and fruits. Output of the unit is about 15 cans or cartons per minute, and it can handle materials ranging in weights from 1 ounce to 2 pounds 4 ounces. Each filled can or carton is check-weighed by the machine before closing. The Arenco Machine Co., 25 West 43rd Street, New York 36, N.Y. (*Canad. Fd. Ind.*, October 1961, p. 102).

INDIAN PATENTS

71720. *Improvements in or relating to apparatus for sealing cartons:* Apparatus for sealing a carton having a lid hingedly connected to the rear wall of its body and provided with side flaps and front flaps adapted to overlie and to be heat-sealed to the side walls and front wall of the carton body—*The Metal Box Company Limited.*

71241. *Method and apparatus for producing alimentary paste foods from starchy flours of low protein content:* Vacuum treating flours mixed with hot water, pressing, heating and extruding through press—*Gebruder Buhler.*

71275. *Whole milk powder and process for preparing the same:* Wherein the preheating, concentration under reduced pressure, homogenization, spray drying and agglomeration are done under specified conditions—*Afico S.A.*

71413. *Process for the production of methionine:* Reacting 5 per cent solution of methyl thiopropionic aldehyde in dilute alcohol with ammonia and hydrocyanic acid, releasing pressure in distillation column and sponity reaction mixture freed of solvent—*Inventa A.G. Fur Forschung Und Patentverwertung.*

70429. *Method for producing organoleptically bland protein and products thereof:* Extracting protein from an alcohol treated soybean material by aqueous extraction medium at pH 6.8-11, precipitating protein from the extract by adjusting pH to 5 to 5.4, recovering protein as a curd and drying the curd at a temperature not exceeding 60°C.—*J. R. Short Milling Co.*

FOREIGN PATENTS

B.P. 839,354. *Black tea concentrates:* A black tea concentrate containing the original flavour and aroma is produced by concentrating an aq. extract of unprocessed green tea leaf at 80-90°, initially with exposure to O_2 until 3-4 per cent of the solution has been evaporated, separating and distilling this percentage of evaporated solution, completing the concentration of the remaining solution to desired strength, and combining the final concentrate with the previously separated fraction. Preferably treatment of the extract with O_2 may be effected in presence of $KMnO_4$ (0.03-0.06 per cent) The process is simplified by barring excess of air to the initial green tea extract, concentrating in vacuo to the desired consistency and then exposing to air at 80-90°C optionally in the presence of $KMnO_4$. *Transcontinental Development Co.* (*J. Sci. Fd. Agric.*, August 1961, p. ii-77).

B.P. 843,787. *Dextrose products:* A hard, semi-cryst., free-flowing, dextrose product stable against loss of β-content, consisting essentially of 85-95 per cent of dextrose, 5-15 per cent of sol. polysaccharides, >4 per cent of moisture, and substantially free from α-dextrose hydrate is produced by heating and drying at $>50°$ an aq. solution containing dextrose (85-95) and sol. polysaccharides (5-15 per cent) in presence of a cryst. or semi-cryst. phase of dextrose, the polysaccharides being derived from a starch hydrolysate consisting of an enzymically-converted starch containing 5-95 per cent of polysaccharides or an acid-converted starch containing 60-95 per cent of polysaccharides. The final product, especially useful in the manufacture of soft drinks is further characterised by being sol. in water (at 25°C) up to a concn. of 50 per cent without separation of α-dextrose hydrate—*Corn Products Co.* (*J. Sci. Fd. Agric.*, October 1961, p. ii-172).

B.P. 841,316. *Cocoa-butter substitutes and their use in chocolate and confectionery:* A product suitable for use (5-30 per cent) as a substitute for cocoa-butter (in the manufacture of chocolate) comprises a lard fraction, softening point 35-45°, I val. 25-40, dilatition <1200 at 20°, obtained by subjecting lard to fractional crystallisation from a solvent, *e.g.*, acetone. A similar product is made from beef or mutton tallow—*Unilever Ltd.* (*J. Sci. Fd. Agric.*, October 1961, p. ii-182).

B.P. 842,817. *Foodstuff from oil-containing animal materials such as fish and fish offal:* The oil containing material is subjected to mechanical disintegration, and the result pulp is treated with enzymes (<3 h. at 20-50°) by adding a substrate of a fermented dead culture of lactic acid-producing bacteria (*Lb. casei*). After subsequent separation of the oil the treated pulp is adjusted with (formic) acid to pH 3.6-4.2. The product (0.3-0.5 per cent of oil) is stable for several months and may be spray-dried—*H. M. Ehlert and I. Mikkelsen* (*J. Sci. Fd. Agric.*, October 1961, p. ii-191).

B.P. 846,262. *Flour of improved biscuit-making properties:* The biscuit-making properties of flour are improved by adding thereto a modifier, *viz.*, an extracellular proteinase derived from *B. subtilis*, cysteine, cystine, glutathione and/or a salt of the last three (to convert the protein of the flour into relatively large molecular units), so that the unyeasted dough made from the mixture has an extensibility of <18 and a spring value of >330—*Research Association of British Flour Millers* (*J. Sci. Fd. Agric.*, November 1961, p. ii-223).

B.P. 844,514. *Coffee extract in the form of a dry powder:* A process for the production of a dry coffee extract in powder form comprises making from ground, roasted whole beans an aq. infusion (containing flavour and aroma), adding and homogenising with a non-fatty, low-boiling org. solvent (*e.g.*, light petroleum b.p. 36-45°, chloroform or dichloroethylene, 2-28 vol- per cent); then desiccating the mixture, *e.g.*, at 65-85° by spray-drying—*E. Griffiths Hughes Ltd.* (*J. Sci. Fd. Agric.*, November 1961, p. ii-232).

B.P. 869,356. *Treating food products:* To prevent undesirable discolouration of fruits and vegetables after cooking, calcium and/or magnesium acid salts of organic complex-forming acids, are added to the products whilst being cooked —*Joh. A. Benckiser G.m.b.H.* (*Food Trade Rev.*, August 1961, p. 80).

B.P. 871,468. *Cleaning dried fruit:* In a method for cleaning dried fruit such as currants, raisins and sultanas, which enables most of the impurities to be removed automatically in the various treatment steps thereby reducing the time and labour required for final inspection, the dried fruit is fed to a screening device to remove the finer and lighter contaminants, then into a vessel through which is passed a stream of liquid so that the fruit is floated on the surface and allows the heavier contaminants to fall, and then into a vessel where it is subjected to a cyclonic action to remove further impurities before passing to a drying machine from which it is discharged for final inspection and sorting by manual labour—*Burgess Engineering Stoke-on-Trent, Ltd.*, (*Food Trade Rev.*, September 1961, p. 101).

B.P. 872,323. *Ground meat products:* Relates to improvements in the processing of meat for use in the manufacture of sausage and other ground meat products whereby the binding or emulsion forming properties of the meat proteins can be fully conserved and utilised: meat from a freshly slaughtered animal is frozen solid before rigor mortis sets in, and is maintained in a solid frozen condition until such time as it is to be used, and is at least coarsely comminuted either before freezing or while in an unthawed condition and soluble protein promptly extracted in the presence of salt water upon thawing—*Oscar Mayer and Co.* (*Food Trade Rev.*, September 1961, p. 101).

B.P. 873,580. *Separating starch:* A process for the separation of starch and proteinaceous matter in wheat or maize flour comprises reacting the flour with an aqueous solution containing copper and sulphite ions, until substantially all the proteinaceous matter is solubilized, the starch remaining substantially unaltered at the end of the process: the solution preferably comprises copper sulphate, ammonia and sodium sulphite—the preferred concentration of copper sulphate is 0.02 M and that of sodium sulphate 0.05M—*The Research Association of British Flour Millers and Another* (*Food Trade Rev.*, September 1961, p. 102).

B.P. 875,218. *Bread manufacture:* Relates to a dough moulding machine delivering an elongated roll of dough divided into an even number of separate equal sections with the 'grain' running longitudinally thereof: the object is to enable 'sectional' bread to be produced without the recurrent changes in crumb texture and colour which occur when the dough piece has been previously folded in known manner and without the limitations which the known method of manually parallelising the separate sections imposed upon speed and uniformity of production.—*Thomas Barker & Sons, Ltd., and Others* (*Food Trade Rev.*, October 1961, p. 85).

B.P. 873,706. *Cartons:* Relates to the use of waxed paper containers of the kind used extensively for the packaging of fruit drinks of the 'still' (non-effervescent) type, but which are unsuitable for the storage of pressurised contents: a receptacle *e.g.*, in the form of a cup-shaped paper element secured to the interior of the scored portion of such a container, serves to enclose a tablet composed of effervescent ingredients which, when released into the drink by pressing out the scored portion, renders the drink effervescent.—*G. R. Rhodes* (*Food Trade Rev.*, October 1961, p. 85).

B.P. 874,087. *Coffee-making machines:* Relates to improvements in machines for making so-called 'expresso' coffee, designed to overcome certain disadvantages existing with such machines, *e.g.*, if the machine is not regularly used the dispensing heads become relatively cold and the coffee dispensed is not of the same quality as when the heads are at the optimum temperature, and if the machine is used too frequently the heads become heated to a temperature above the optimum and the coffee acquired a 'burnt' taste:—*E. Valente* (*Food Trade Rev.*, October 1961, p. 86).

B.P. 874,537. *Protein food products:* In a process for preparing a cheese-like product from groundnut protein fat is added to an aqueous suspension of groundnut protein which is then homogenised and heated to at least 80°C to facilitate curd formation by the action of acid—the curd cut, drained, pressed and stored until the desired cheese-like flavour develops.—*Unilever, Ltd.*, (*Food Trade Rev.*, October 1961, p. 86).

B.P. 878,478. *Coffee making device:* Relates to an apparatus for automatically brewing and vending coffee, in which the coffee is brewed in, stored in, and dispensed from a single, relatively large container, in increments of, *e.g.*, a cup, and as dispensing takes place, the supply of coffee in the container is automatically replaced by charges of water and ground coffee being fed thereto.—*Automatic Canteen Co.* (*Food Trade Rev.*, November 1961, p. 87).

B.P. 877,784. *Coffee extract:* Relates to a process of preparing an 'instant' coffee extract wherein roasted ground coffee is subjected to an initial extraction step with relatively cold extraction medium to obtain a first liquid extract, and the partially extracted coffee solids subjected to a second extraction step with relatively hot extraction medium to obtain a second liquid coffee extract, at least one of the extractions being carried out in the presence of ultrasonic vibrations—*Curtiss-Wright Corp.* (*Food Trade Rev.*, November 1961, p. 87).

B.P. 878,502. *Fruit juices:* A process for cold bottling or canning of fruit juices and concentrates to improve the flavour of the final product, comprises heating the liquid to from 75°C to 96°C for from 10 to 30 secs.: cooling the liquid to from 0°C to 25°C: filling the containers with the cooled liquid and sealing, these two latter steps being carried out in a sterile atmosphere—shortly before and during filling, a stream of sterile inert gas, *e.g.*, nitrogen, is projected into the containers replacing the air already present—*C. S. Schmerbeck* (*Food Trade Rev.*, November 1961, p. 87).

U.S. 2,982,656. *Colouring foods*, by contacting them with alkali metal salt of curcumin that is acid-liberated from its alkali metal salt—*E. E. Langenau, Fritzsche Bros.*, (*Food Engng.*, August 1961, p. 104).

U.S. 2,970,914. *Producing a fully* roasted fluid coffee concentrate from raw coffee beans—*M. Bonotto, Princeton, N. J.* (*Food Engng.*, September 1961, p. 130).

U.S. 2,976,156. *Adding antioxidant* to steam-deodorized oil to improve keeping qualities—*A. Roylance, Lever Brothers Co. N.Y.C* (*Food Engng.*, September 1961, p. 130).

U.S. 2,976,158. *Foam-drying* coffee concentrate to produce readily rehydratable dried product—*A. I. Morgan, Jr., USDA.* (*Food Engng.*, September 1961, p. 130).

Information from Foreign Journals

THE CFTRI has a Technical Translation Service which surveys technical and scientific publications in modern European languages in the fields of Food Science and Technology. The Service offers facilities of translation of scientific articles mainly from German, French, Dutch and Italian periodicals and covers a large number of publications in these languages. The translated material is made available to research workers and industries for their use on terms specified by the Institute. Lists of the translated contents of foreign journals and of the available translated articles are given in this section.

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IN MEMORIAM

Dr B. C. GUHA

We record with deep sorrow, the untimely demise (on 20th March 1962 at 11-30 p.m.) of Dr B. C. Guha, a leading Scientist who made his mark as a Biochemist both in the National and International fields and was the President-elect of Indian Science Congress for 1963. He was associated with the Central Food Technological Research Institute, Mysore from its very inception in 1950 as a Member of the Executive Council and its Scientific Advisory Committee in which capacities he rendered invaluable service to the Institute during its research and developmental progress. He was not only appreciative of the Institute's achievements as a Centre of research, training and advice in the fields of food science and technology, but also carried its banner farther to get the due recognition and application of the results by the policy-making bodies of the Government, Research and Industrial organizations in India. His loss to our Institute in particular is, therefore, irreparable.

Dr Biresh Chandra Guha, the youngest son of the *late* Mr Rash Behari Guha of Banaripara in Barishal district (East Pakistan), was born on 7th June, 1904. He had a brilliant academic career in the Presidency College, Calcutta and started as an educationist under the *late* Acharya Prafulla Chandra Ray in the Science College, Calcutta. He had his Postgraduate training at the Universities of London and Cambridge. He was the author of numerous scientific publications.

Noted for his research in Biochemistry with special reference to food and nutrition, he was the Chief Technical Adviser in the Department of Food, Ministry of Food and Agriculture, Government of India, during 1944-1947. He was the President of the Chemistry Section of the Indian Science Congress for the year 1945 and a Member of the International Committee for Biochemistry 1949-54. He was Chairman of the Damodar Valley Corporation during 1948-53, Member of the Indian Universities Delegation to the Moscow University in 1954, and Government of India Delegate to the International Congress of Biochemistry at Brussels in 1955. He was for a long period the President of the Society of Biological Chemists, India, Member of the Council of the National Institute of Sciences of India, Chairman of the Nutrition Advisory Committee of the I.C.M.R. and Chemical Research Committee of the C.S.I.R. He was the Ghose Professor of Applied Chemistry, University Science College, Calcutta and Dean of the Faculty of Science, Calcutta University, Calcutta.

As Chairman of the Scientific Food Advisory Panel of the Ministry of Food and Agriculture since 1959, Dr Guha rendered invaluable service in the application of science and technology to the conservation and effective utilization of foods.

Dr B. C. Guha was the Founder-Member of the Association of Scientific Workers of India and its President during 1949-1954. He continued to be its Member till the very last, taking very keen interest in the welfare of scientific workers.

The Institute marked the sad event by a two minute silence meeting, adopting a condolence message to the bereaved family and closing the Institute for the rest of the day.

Food Abstracts

THIS section contains abstracts of papers on Food Science and Technology selected so as to serve the needs of food and allied industries in India and is divided into three parts. Part I comprises abstracts of papers published by the CFTRI, Mysore, reprints of which can be had from the Institute on request. Part II consists of abstracts of papers published in important Indian journals. Part III contains abstracts of important articles from foreign journals.

PART I (Cftri)

The formation of cracks in rice during wetting and its effect on the cooking characteristics of the cereal, by Desikachar, H. S. R. and Subrahmanyan, V., *Cereal Chem.*, 1961, **38** (4), 356.—Formation of cracks in milled raw and parboiled rice during soaking in water above 70°C was found to have been retarded in the former and accelerated in the latter. The soaked rice grains required shorter cooking time than the unsoaked grains and were also longer. The property of the rice grains becoming opaque by the absorption of water was used in studying the mode of water penetration into the rice grains during soaking. It was found that in the initial stages the water entered the grain near its germ end and along the top line of fusion. After some time transverse lines of cracks developed facilitating the entry of water. Soaking helps absorption and hence cooking. —R.C.B.

Note on variations in residual bran in individual rice grains from batches polished to different degrees, by Srirangarajan, A. N., Desikachar, H. S. R., Indiramma, K. and Sankaran, A. N., *Cereal Chem.*, 1961, **38** (4), 391.—A quantitative method for evaluating the degree of polishing in rice has been suggested by the examination of individual rice grains (white varieties) after staining the bran with methylene blue and measuring the colouring matter on individual grains. The rate of bran removal was faster in the early stages of polishing than in the final stages. —R.C.B.

Studies on milk substitutes of vegetable origin, Part III. The nutritive value of spray-dried soyabean milk fortified with Dl-methionine and spray-dried powder from a 2:1 blend of soyabean milk and sesame milk, by Shurpalekar, S. R., *et al.*, *Ann. Biochem. & exptl. Med.*, 1961, **21** (6), 143.—Milk reconstituted from soyabean milk-powder and spray-dried powder from 2:1 blend of soyabean and sesame milk promoted fairly good growth in albino rats as compared with that obtained with reconstituted modified cow's milk having the same protein content. Fortification of soyabean milk-powder with dl-methionine increased its growth-promoting value as well as the protein efficiency ratio of the protein which is lower in soyabean milk alone or its 2:1 blend with sesame milk, to the same level as that of modified milk powder.

The mean haemoglobin level and the R.B.C. count of the blood of rats fed on modified cow's milk and 2:1 blend of soyabean and sesame milk, respectively, were slightly lower ($P>0.05$) than those of the animals fed on milk from soyabean-milk-powder fortified with dl-methionine. No significant differences were observed in the mean moisture, fat, and protein contents of the livers or the carcass of rats fed on different types of milks. Each kind of milk referred to above is reconstituted.

Non-enzymatic browning in foods: Increased discolouration in some natural and synthetic sulphited systems, by Sastry, L. V. L., Bhatia, B. S. and Lal, G., *Indian J. appld. Chem.*, 1961, **24** (1), 35.—The effect of the nature of preservatives on non-enzymatic browning in *jaman* and grape juices, sapota squash, guava pulp, and a few other synthetic systems has been studied.

(*i*) In *jaman* and grape juices, guava pulp and sapota squash, SO_2 enhances discolouration when compared with unsulphited samples.

(*ii*) The purified anthocyanin pigment prepared from *jaman* juice, the methanol extract of sapota pulp, tannic acid and pectin are not responsible for this behaviour of SO_2.

(*iii*) Sulphited lime and mango squashes show less discolouration compared to non-sulphited squashes whereas addition of sapota pulp to sulphited lime squash causes more discolouration than squash preserved by sodium benzoate or by pasteurization.

(*iv*) Other pulps such as those of orange, lime and mango when added to sucrose-glycine synthetic systems, show the well-known protective action of SO_2.

(*v*) There is comparatively little browning in the case of samples containing sapota and mango pulps.

Preservation of alcoholic solution of furfural as a ready reagent for Baudouin test, by Kapur, P. O., *Curr. Sci.*, 1961, **30**, 298.—Results of observations made on the storage in bulk of 2 per cent alcoholic solution of furfural in stoppered amber-coloured bottles at four different temperatures (0—5° C, 25-28°C, 37°C and 43°C (for a period of four weeks, have shown that the solution has stood well as judged by its suitability for use in the Baudouin test. The improvement suggested is a saving of labour and time for the analysts for routine tests.

—R.C.B.

The mucilaginous principles in black gram (*Phaseolus mungo*) **dhal,** by Kadkol, S. B., Desikachar, H. S. R. and Srinivasan, M., *J. sci. industr. Res.*, 1961, **20C** (8), 252.—

The crude mucilage precipitated from the acetate buffer (pH 4.6) extract of black gram flour by acetone (1.5 vo.) has been purified by repeated treatment with Sevag's solvent and final precipitation with acetone. The mucilage contains 3 per cent nitrogen. Chromatographic analysis of the mucilage has revealed the presence of galactose, arabinose, rhamnose and galacturonic acid in the molecular proportion of 13:18:3:2 respectively. The protein component of the mucilage does not contain the sulphur amino acids except traces of methionine.

Studies on some aspects of custard apple peroxidases, by Sastry, L. V. L., Bhatia, B. S. and Lal, G., *J. Food Sci.*, 1961, **26** (3), 244.—A purified peroxidase enzyme solution was prepared from custard apple pulp, and its characteristics studied. Its catalytic effect on oxidizing various aromatic amines and phenols was reported. Ascorbic acid oxidase is shown to be absent in the enzyme extract. The influence of temperature, pH, and concentrations of sulphur dioxide, ascorbic acid, sucrose, potassium cyanide, and hydrogen peroxide on the enzyme activity are indicated. The 'PZ' value for custard apple pulp was found to be 0.06 on dry basis.

Nutritive value of balanced malt foods, by Korula, S., Chandrasekhar, M. R., Indiramma, K., Swaminathan, M. and Subrahmanyan, V., *Indian J. med. Res.*, 1961, **49** (5), 880.—The nutritive value of balanced malt foods based on blends of ragi malt, low-fat groundnut flour, Bengal gram flour, soyabean flour and sesame flour and fortified with calcium phosphate and essential vitamins as compared with those containing skim milk powder, has been studied by experiments on albino rats.

The essential amino-acid compositions of the malt foods were similar to that of FAO reference protein pattern. The protein efficiency ratios of the different malt foods ranged from 2.47 to 2.67 and were significantly less than that (3.54) obtained for milk in a period of 4 weeks.

The average weekly gain in weight of rats on diets containing 20 per cent of protein from the different malt foods over a period of weeks ranged from 15.6 g. to 17.1 g. comparing well with that (16.2 g.) observed on a similar diet containing 20 per cent milk protein.

No significant difference was observed in the haemoglobin and red blood cell count of the blood and the moisture, protein and fat contents of the livers of the different groups of rats fed on the malt foods and milk food respectively.

Insect-proofing of gunny bags for grain storage, by Majumder, S. K., Krishnarao, K. J. and Sethumadhavan, H. G., *Res. & Ind.*, 1961, **6** (11), 391.—An oil-in-water emulsion containing Lindane and DDT, with a high degree of persistence and insecticidal effectiveness, has been standardized for spray treating empty gunny bags to render them insect-proof. The technique developed for large scale insect-proofing of gunny bags and other fabrics is described. Both new and old gunny bags can be made insect-proof for storage of food grains free from insect infestation under rural and urban conditions. The cost of treatment works out to about 9 nP. per gunny bag.

PART II (Indian)

ANALYTICAL

Studies in the physico-chemical properties of milk—Part X. Determination of freezing point of milk by Beckmann technique and the calculation of added water, by Puri, B. R. and Parkash, S., *Indian J. Dairy Sci.*, 1961, **14**, 73.—Freezing point depression of milk was found to be fairly constant and almost independent of its composition, the lactation period the feed of the animal, the season of the year, the stages of milking, abstraction of fat, etc.

Goat milk gave a slightly higher value than cow or buffalo milk, which, however, gave almost identical values.

The addition of 4-5 per cent of tap-water to buffalo or cow milk lowered the freezing point depression appreciably to enable its detection. The formula for calculating the amount of extraneous water, proposed by Elsdon and Stubbs, did not give satisfactory values. Two relationships between the freezing point depression and the amount of water added—one valid up to 10 per cent, addition and the other valid beyond 10 per cent addition of water—were worked out.

The effect of adding various preservatives, commonly used, was also studied and a correction factor for each preservative calculated.

Qualitative detection of essential and semi-essential amino acids in rice polishing concentrate, by Chakrabarti, C. H., Saxena K. L., Morey, K. S. and Nath, M. C., *Sci. & Cult.*, 1961, **27**, 441. —By the two dimensional paper chromatographic technique for the detection of amino acids using Whatman filter paper No. 1 and solvent mixtures of butanol: acetic acid: water (4:1:5) and then pyridine: isoamyl alcohol: water (10:10:7), developing the chromatogram by means of 0.4 per cent ninhydrine in 95 per cent aqueous acetone and keeping it in oven at 60°C for 15 minutes it has been shown that the rice polishing concentrate contains lysine, leucine, isoleucine, threonine, valine, phenylalanine, arginine and cystine and no tryptophane, methionine.

—R.C.B.

A rapid colorimetric assay method of streptomycin and dihydrostreptomycin in mixtures, by Agrawal, K. C. and Dutta, B. N., *Sci. & Cult.*, 1961, **27**, 450.—The assay of streptomycin sulphate is done by adding 3 ml. of 0.1 per cent picric acid followed by 2 ml. of 5 per cent NaOH (AR) to each of the seven tubes containing 5 standard, one sample and one blank, all of which are then heated in boiling water for 3 min. cooled and made up to 10 ml. measuring the red colour in Klett Summerson photoelectric colorimeter using Filter No. 50 against the blank. A standard calibration curve is constructed and the concentration of streptomycin sulphate found by extrapolation from the curve. The concentration of dihydrostreptomycin sulphate in the test solution is measured in terms of streptomycin sulphate by extrapolation from the standard calibration curve multiplied by 1.0027. The method is claimed to be rapid, accurate and reproducible.

—R.C.B.

Oxidimetric method of evaluation of volatile oils of spices, by Misra, R. C. and Krishna Rao, G. S., *J. sci. industr. Res.*, 1961, **20 (D)**, 9, 331.— A method for accurate determination of the essential oil content of spices when small quantities of the spices are available is described. A special feature of the apparatus developed for the estimation is that it enables the whole of the distilled oil to be brought into intimate contact with the oxidizing agent and the titration is carried out in the same flask eliminating transfer losses. The results obtained are comparable to those obtained by direct hydrodistillation using macro quantities.

BIOCHEMISTRY AND NUTRITION

Effect of rice polishings concentrate on the nutritive value of some Indian pulses, by Chakrabarti, C. H., Saxena, K. L. and Nath, M. C., *Ann. Biochem. & exptl. Med.*, 1961, **21** (8), 237.—The influence of rice polishings concentrate on the protein efficiency ratio, biological value, digestibility, and protein value of Bengal gram, black gram, red gram, green gram and lentil has been studied using growing albino rats.

Supplementation with rice polishings concentrate significantly improved the protein efficiency ratio as well as biological value of these pulses.

The digestibility and protein value of Bengal gram, black gram, red gram and lentil are increased by the addition of rice polishings concentrate.

The effect of a low-refined-carbohydrate high-protein diet upon non-fasting blood calcium, by Page, M. E., Ringsdorf, W. M., Cheraskin, E. and Hollis, C. F., *Ann. Biochem. & exptl. Med.*, 1961, **21**, (11), 327.—Non-fasting serum calcium analyses of 493 patients were made initially (during a period of regular diet) and 3 days after a high-protein low-refined-carbohydrate regimen.

It appears from the results that the changes which occur with this dietary programme become significant with advancing age.

It would appear, at least presumptively, that 9.7 mg. per cent (Kramer-Tisdall-Clark method) and 10.0 mg. per cent (spectrophotometric method) well be the ideal non-fasting serum calcium level.

Clinical trials with roasted-groundnuts in cases of protein malnutrition—kwashiorkor, by Jayalakshmi, V. T. and Mukundan, R., *Indian J. med. Res.*, 1961, **49** (6), 1130.—It was observed that vegetable protein diets in our cases proved as good as skim milk to control protein malnutrition.

Vegetable protein, i.e., groundnut containing diet is as efficient as Bengal gram diet given by other workers.

Like other workers we also observed that the difference between the vegetable protein diet and animal protein diet was most marked on the 10th day of treatment and it narrowed down by the 30th day.

Detection of some less known amino acids in common Indian pulses and vegetables, by Deshmukh, A. D. and Kamala Sohonie, *J. sci. industr. Res.*, 1961, **20C**, (11), 330.–Nineteen common Indian pulses and vegetables have been examined for the presence of less known amino acids, *viz.*, canavanine, -aminopropionitrile, -nitro-propionic acid, -aminobutyric acid and pipecolic acid. Pipecolic acid and -aminobutyric acid occur in most of the vegetables and only a few pulses contain pipecolic acid.

-Nitropropionic acid does not occur in any of the pulses or vegetables investigated.

DAIRY PRODUCTS

Effect of pasteurisation and cold storage on xanthine oxidase activity in milk, by Krishna Iyengar, M. K. and Laxminarayana H., *Indian J. Dairy Sci.*, 1961, **14** (3), 130.—Effect of pasteurisation (63°C for 30 minutes) and storage at 5°C. on the xanthine oxidase activity in milk and cream has been studied by following the reduction of tetrazolium in presence of xanthine under anaerobic conditions.

There was a marked increase in the enzyme activity in milk as a result of pasteurisation treatment or cold storage. In the case of cream, pasteurisation caused a decrease in the enzyme activity.

ENZYMES

Localization of starch phosphorylase in the leaves of tapioca plant, by Srivastava, L. M. and Krishnan, P. S., *J. sci. industr. Res.*, 1961, **20C**, (11), 306.—A significant proportion of the total phosphorylase activity in the leaves of the tapioca (*Manihot utilissima*) plant is found to be associated with the plastid fraction sedimenting at centrifugal forces of *c.* 1600 g. from homogenates prepared in aqueous media. As regards the activity found in the supernatant, it is difficult to decide whether a soluble enzyme is present along with the particles-bound enzyme, or whether the soluble enzyme is an artifact arising from plastid rupture during homogenization and centrifugation. When the chloroplast fraction is separated into stroma and grana, the greater part of the enzymic activity is found in the former. Dialysis of the whole homogenate leads to a change in the distribution pattern in the direction of increased activity in the supernatant, but an appreciable part of the total activity is still associated with the particulate fraction. Dialysis of the separated plastid fraction leads to very little solubilization of enzyme. A major part of the phosphorylase activity of the sweet potato (*Ipomoea batatas*) leaves is also found to reside in the sedimentable fraction. In the case of potato (*Solanum tuberosum*) leaves, however, over 75 per cent of the phosphorylase activity is present in the supernatant.

MEAT AND FISH

Nutritive value of canned fish: Effect of canning, storage and antioxidants, by Sawant, P. L. and Magar, N. G., *J. sci. industr. Res.*, 1961, **20D,** (8) 313.—The effect of canning and storage in the presence and absence of antioxidants, on the nutrients in black and white pomfrets and prawns has been studied. Canning has been found to denaturate the proteins and result in significant loss in thiamine; riboflavin, niacin and the amino acid contents of the fish are not adversely affected.

On storage, there is marked loss of lysine, arginine, methionine and tryptophan. Riboflavin and niacin are more stable than thiamine. The extent of the losses increases with rise in storage temperature. Nordihydroguairetic acid and ascorbic acid when present together prevent discolouration of the canned product.

Propionic acid as a preservative for cured fish products, by Valsan, A. P., Rajendranathan Nair, M. and Suryanarayana Rao, S. V., *J. sci. industr. Res.*, 1961, **20D,** (9) 351.—The possibilities of employing chemical preservatives as adjuncts to the conventional methods of preserving cured fish have been explored. Of the various chemicals tried, propionic acid was found to be most promising when used for wet-salted and pickled fish. It helps in completely suppressing red halophile attack and mould growth which constitute the major causes of spoilage in cured fish.

MICROBIOLOGY

Heat resistance and shape of destruction rate curves of sporulating organisms, by Anand, J.C., *J. sci. industr. Res.*, 1961, **20C,** (10) 295.—The nature of heat destruction curves of seven sporulating aerobic and anaerobic organisms, *viz.*, *B. megaterium*, *B. cereus*, *B. subtilis*, *B. brevis*, *B. stearothermophilus*, *Cl. sporogenes* and *Cl. bifermentans*, has been studied. Only four of the organisms investigated have been found to give logarithmic order of destruction, *i.e.*, linear curves, while others give non-linear curves. The non-linear destruction curves of *B. stearothermophilus* at three levels of initial counts have been found to be parallel. *B. stearothermophilus* has been found to have a thermal death time value about 1000 times higher than that for *B. megaterium* and twice that for *B. brevis.*

OILS AND FATS

Studies on the nutritional quality of hydrogenated niger seed oil, by Basu, H. N. and Chakrabarty, M. M., *J. sci. industr. Res.*, 1961, **20C,** (8) 244.—The digestibility and non-toxicity of hydrogenated niger seed oil have been compared with a proprietary hydrogenated fat using rats as the experimental animals. The digestibility co-efficient has been found to be of the order of 94-97 per cent in the case of both the fats. No appreciabel difference has been observed in the growth rate of rats fed on the two fats. It has been concluded from these studies that niger seed oil can be used safely for the manufacture of edible hydrogenated fat.

PACKAGING

Fillers for PF plastics from coir waste and coconut pith, by Prabhu, G. N., *Res. & Ind.*, 1961, **6** (8), 276.—Large amounts of coconut pith and coir waste are available in India as byproducts from the retting of coconut husks and coir processing industries. The disposal of these materials has been a perennial problem for the industry. However, it is now possible to put them to profitable use as a result of investigations conducted by the Research Wing of the Coir Board. Moulding powders capable of giving products of good strength and impact resistance have been prepared using coir waste as the material. The performance of the powders under commercial moulding conditions has been tested and encouraging results have been obtained.

VITAMINS

Influence of cobalt on the synthesis of vitamin B_{12} in sewage during aerobic and anaerobic treatment, by Sathyanarayana Rao, S. and Srinath, E. G., *J. sci. industr. Res.*, 1961, **20C** (9), 261.—A comparative study has been made on the influence of cobalt on the synthesis of vitamin B_{12} in sewage sludges formed under aerobic and anaerobic conditions. The effect of varying the amount of cobalt, from 1 to 50 p.p.m., on the purifying action of activated sludge has also been studied. The experimental evidence on these and related aspects indicated that the conditions in the activated sludge process are more favourable for the synthesis of vitamin B_{12} and that this is facilitated with 1 p.p.m., cobalt added to the sewage. Cobalt at this concentration brings about 50 per cent increase in vitamin B_{12} content of the sludge but does not seem to affect the process of purification or the nitrogen and phosphorus contents of the sludge.

PART III (Foreign)

ANALYTICAL

Comparing three rapid methods of detecting spoilage in meat, by Saffle, R. L. *et al.*, *Food Technol.*, 1961, **15** (11), 465.—This study was conducted in an attempt to find a rapid method for determining the shelf life of meat. The three rapid methods studied were resazurin reduction, picric acid turbidity, and ninhydrin. Resazurin reduction to colourless had a correlation with odor score of r= 0.92, and with total bacterial counts of r=0.80, indicating that it is a good predictor of meat quality. The estimating equation and per cent error of the estimates were given.

Both odor scores and total bacterial counts were significantly correlated with picric acid turbidity and with ninhydrin test, but not enough to be of practical value. The picric acid extract was heat-labile, and the time between filtering and reading the OD greatly affected the results.

Determination of butylated hydroxyanisole and butylated hydroxytoluene in potato granules by gas-liquid chromatography by Buttery, R. G. and Stuckey, B. N., *J. agric. Fd. Chem.*, 1961, **9** (4), 283.—A rapid and specific method for the quantitative analysis of low levels of butylated hydroxyanisole and butylated hydroxytoluene in dehydrated potato granules using gas-liquid chromatography with flame ionization detection is described. The method is shown to give analyses with an average error of less than 11 per cent from the true concentration for both antioxidants within the range 0.5 to 10 p.p.m. of antioxidant in the granules.

Differentiation of synthetic and natural caffeine, by Allen, A. B., *J. agric. Fd. Chem.*, 1961, **9**, (4), 294.—C^{14} radioactivity of CO_2 derived from the combustion of caffeine has been used to differentiate synthetic from natural caffeine. Application of this method obviously is not restricted to caffeine, but to any natural synthetic pair in which the synthetic one is made from dead carbon.

Identification of caffeine as natural or synthetic, by Weinhauff, O. J., *J. agric. Fd. Chem.*, 1961, **9** (5), 397.—Infra-red absorption and radiocarbon dating methods were developed and used to identify caffeine as of natural vs. synthetic origin. By convention natural caffeine refers to that extracted from tea or coffee as well as that prepared by methylation of theobromine extracted from cocao beans. Synthetic caffeine includes that prepared by synthesis from urea and from 1,3-dimethylurea. Infrared identification of characteristic components in alkali-soluble residues extracted from caffeine was used to differentiate between natural and synthetic products. A radiochemical method based on measurement of C^{14} in natural caffeine derived from $C^{14}O_2$ in the atmosphere was used to differentiate the natural from the synthetic compound which is composed of essentially dead carbon from petroleum or coal sources. The sample is burned, carbon dioxide is collected as calcium carbonate, and the radioactivity of the evolved gas measured. Representative caffeines from domestic and foreign sources were identified properly. The principles and techniques should serve for better identification of other organic products from natural and synthetic sources.

Pesticide residues on fruit. II—Determination of aldrin, dieldrin and endrin residues by the organic chlorine and phenyl azide methods and by microbioassay, by Tew, R. P. and (Miss) Sillibourne, J. M., *J. Sci. Fd Agric.*, 1961, **12** (9), 623.—An account is given of important modifications to the organic chlorine and phenyl azide methods for the determination of aldrin, dieldrin and endrin, and a comparison is made between the results obtained by these methods and by microbioassay.

BAKERY PRODUCTS

Some observations on the continuous process of breadmaking, by Bottomley, R. A., *Food Technol.*, 1961, **15** (10), 423.—A pre-ferment containing all ingredients except flour, major oxidizing agents, and shortening constitutes an essential part of the continuous system of breadmaking, which is briefly described. In a standard sucrose pre-ferment the sugar utilization, alcohol, carbon dioxide, acidity, etc., changes are shown to be essentially those of an anaerobic, alcoholic fermentation. Yeast growth was measured by cell counts and by measuring major and minor axes after photographing representative fields and subjecting the results to statistical treatment. Highly significant increases were noted, and cell budding increased from 1.5 per cent to 9.5 per cent. The addition of thiamine, riboflavin, and niacin in amounts sufficient to ensure that the resultant bread complied with U.S.A. standards for enriched bread, stimulated yeast growth and fermentation changes. The addition of sodium diacetate, a 'rope' and mold inhibitor, increased the acidity and slightly depressed yeast activity. No increase in the number of budding cells was noted. Substituting maltose in the form of non-diastatic malt extract for sucrose (on an equivalent cost basis) in the presence of sodium diacetate slowed fermentation markedly, though this was not reflected in the experimental bread, which, however, had a different flavour. It is possible that limitations of the apparatus used to produce the dough could obscure differences due to pre-ferment components. It is suggested that a pre-ferment time of less than the 2 hours used commercially could be beneficial.

BIOCHEMISTRY AND NUTRITION

Nutritive value of Central American beans. IV. The essential amino acid content of samples of black beans, red beans, rice beans, and cowpeas of Guatemala, by Bressani, R., Elias, L. G. and Navarrete, D. A., *J. Food Sci.*, 1961, **26** (5), 525.—The rice bean (*Phaseolus calcaratus*), cowpea (*Vigna sinesis*), red bean and three black bean (*Phaseolus vulgaris*) samples grown in Guatemala, were found to be fairly similar in chemical composition. Average percentage values were: moisture 14.5, protein 22.3 ether extract 1.3, ash 3.5, crude fibre 6.0, and carbohydrate 52.4. The range in amino acid content, expressed as mg. of amino acid per gram of nitrogen, was: arginine 356-528, histidine 159-232, isoleucine 143-339, leucine 189-260, lysine 322-544, total sulfur-containing amino acids 80-94, phenylalanine plus tyrosine 362-471, tryptophan 52-73, threonine 215-348, and valine 191-383. The cowpea sample was higher in lysine; the rice bean and red bean samples were higher in tryptophan. The isoluecine and valine contents were lower, and the leucine higher, in the red beans than in the other samples. When compared with the amino acid pattern of the FAO Reference Protein, methionine plus cystine was the most-limiting amino acid, and leucine and tryptophan respectively the second- and third- most limiting. All the samples contained high amounts of lysine, making beans a good source of this amino acid.

Effect of processing on distribution and in vitro availability of niacin of corn (*Zea mays*), by Bressani, R., Gomez Brenes, R. and Scrimshaw, N. S., *Food Technol.*, 1961, **15** (10), 450.—Niacin distribution was studied in one 'starchy' and one 'flint' sample of yellow corn. On the basis of 10 per cent moisture, the seed coat averaged 3.2 mg., and the endosperm and the germ 2.0 mg. per 100 g. each. The endosperm contributed 80 per cent of the total niacin, whereas the germ and the seed coat respectively supplied 11 and 9 per cent. Of the niacin in the endosperm, germ and seed coat, respectively 55, 73, and 42 per cent were extractable with water at room temperature. During the lime cooking, the endosperm lost an average of 19 per cent of its niacin, and the germ 56 per cent. The cooking liquor contained 0.43 mg. per 100 g. of niacin, equivalent to a total loss of around 22 per cent. Of the niacin in raw corn, nixtamal (masa), and tortillas, respectively about 68, 76, and 73 per cent were extractable with water at room temperature. Hydrolysis with pepsin yielded about 69 per cent of the niacin of all samples. After trypsin hydrolysis, and final digestion with pancreatin, values of 78 and 100 per cent of the niacin, respectively, were found compared with sulfuric acid hydrolysis of the same material. Differences in amino acid balance rather than in bound niacin thus appear responsible for the differences between raw and processed corn in biological activity and pellagragenic action.

Effect of varied levels and a single daily supplement of lysine on the nutritional improvement of wheat flour proteins, by Yang, S. P., Clark, H. E. and Vail, G. E., *J. Nutr.*, 1961, **75** (2), 241.—Experiments were conducted to study the effect of various levels of lysine supplementation on the nutritional value of the wheat flour proteins for the young rats, and to study further whether the lysine supplement administered apart from the diet once a day was as well utilized as the same amount of supplement incorporated in the diet.

Growth data and the biological value indicated that the nutritional value of the flour proteins was improved by the lysine supplementation up to a level of 0.20 or 0.25 per cent, but that liver and carcass composition afforded little information of value at these levels. Certain adverse effects occurred when the flour diet was supplemented with 1.0 per cent of lysine.

When food intakes were equalized at a sub-optimal level, growth data and the biological value obtained with lysine supplementation by stomach tube were similar to those with the supplementation in the diet. Growth data and the biological value obtained with the lysine supplement administered apart from the diet, either immediately or 4, 8, 12 or 16 hours after the 4-hour feeding period, were not different from those observed with the lysine supplement incorporated in the diet.

An evaluation of the FAO amino acid reference pattern in human nutrition—I. Studies with young men, by Swendseid, M. E. *et al.*, *J. Nutr.*, 1961, **75** (3), 295.—Twelve young men were subjects for a study comparing the Food and Agriculture Organization (FAO) amino acid reference pattern and the amino acid pattern of egg as to their effects on nitrogen equilibrium at a constant total nitrogen intake of 10g. per day.

In diet periods wherein the chief source of amino acids was a purified mixture, for both FAO and egg patterns, the nitrogen balance value were not consistently different from diet periods wherein the chief source of amino acids was egg.

When the diets were planned according to the FAO or egg pattern with the amino acids proportioned to an equal amount of tryptophan for both patterns, better nitrogen balance was obtained with egg pattern. When the diets contained isonitrogenous amounts of the amino acids according to the FAO or egg pattern, similar nitrogen balance values were found. Reducing the tryptophan content of the diets containing amino acids in FAO pattern proportions by approximately 20 per cent had no effect on nitrogen equilibrium.

With either FAO or egg pattern, the total amount of essential nitrogen required in the diet to maintain nitrogen equilibrium in the young men under the conditions of this study ranged from 1.0 to 1.3 g. per day.

Digestion and absorption of disaccharides in man, by Dahlqvist, A. and Borgstrom, B., *Biochem. J.*, 1961, **81** (2), 411.—Human subjects have been given the disaccharides sucrose, maltose or lactose, or the polysaccharide starch, in a test meal containing protein, homogenized fat and a non-absorbable reference substance, polyethylene glycol. Intestinal contents were collected by intubation, and the amount of hydrolysis and absorption of carbohydrates were calculated and compared with the carbohydrase activity of the samples.

The limited hydrolysis of disaccharides in the intestinal contents, and the extremely low glycosidase activities relative to the calculated amount of carbohydrate absorbed, indicated that the majority of disaccharides were absorbed unhydrolysed, followed by subsequent intracellular hydrolysis.

Lactose was absorbed in the duodenum and proximal jejunum, maltose in the jejunum and proximal ileum and sucrose in the distal jejunum and in the ileum.

Ingested starch was rapidly hydrolysed to di- and oligo-saccharide by amylase present in the intestinal contents.

Amino acid composition of proteins in wheat gluten, by Woychik, J. H., Boundy, J. A. and Dimler, R. J., *J. agric. Fd Chem.*, 1961, **9** (4), 307.— The recent chromatographic isolation of purified protein components from wheat gluten resulted in a program of basic studies on the structure of these proteins as related to the unique physicochemical properties of gluten. The first step was determination of the amino acid composition of six gluten components or fractions. While their compositions were similar, significant differences were observed which indicate the individuality of these components. Glutamic acid and proline together accounted for one half or more of the peptide-bound amino acids, and therefore probably are of particular structural importance in the gluten proteins. The composition of a water-soluble fraction isolated from gluten preparations indicated that it corresponds to albumins and/or globulins wheat.

Amino acids in soyabean hulls and oil meal fractions, by Rackis, J. J. *et al.*, *J. agric. Fd. Chem.*, 1961, **9** (5), 409.—Amino acids were determined by ion exchange chromatography on soyabean hulls, dehulled soyabean meal, isolated soyabean protein, and the residue; on whey proteins obtained by isolation of the acid-precipitated protein; and on the hypocotyl and the acid-precipitated protein of the hypocotyl. Pre-treatment of meal and other fractions prior to colorimetric determination of tryptophan is described. Essential amino acid composition of soyabean meal fractions varied considerably indicating that biological values of the protein in these fractions also differ. Soyabean hulls contained unusually large amounts of glycine and hydroxyproline. Dehulled meal and residue contained no hydroxyproline.

The alleged 'thiamine-destroying factor' in soyabeans, by Weakley, F. B., Eldridge, A. C. and McKinney, L. L., *J. agric. Fd. Chem.*, 1961, **9** (6), 435.—For 15 years, the literature has contained an unrefuted postulation that soyabeans contain a thiamine-destroying factor. This postulation is based on loss of thiamine added to aqueous slurries of soyabean meal, and an analogous observation with oriental millet meal which caused thiamine deficiency symptoms on bioassay. Data presented here show that the reported loss of thiamine is based on an unreliable thiochrome assay procedure, and that the analogy with millet meal is untenable. Thiamine in soyabean meal exists as 40 per cent free and 60 per cent bound, presumably as cocarboxylase. Enzymes in unheated meal readily convert cocarboxylase to thiamine. Thiamine stability at neutral pH is decreased by addition of phenolic compounds, and increased by absence of air or addition of (ethylenedinitrilio) tetraacetic acid.

DEHYDRATION

Cellulose crystallinity and the reconstitution of dehydrated carrots, by Sterling, C. and Shimazu, F., *J. Food Sci.*, 1961, **26** (5), 479.—Blanched and unblanched dice of carrot phloem were dehydrated at two different rates and stored for periods up to 6 months. The rehydrated volume was always greater for blanched dice than for unblanched. In all samples, the rehydrated volume decreased as a result of storage. No consistent differences among samples could be attributed to differences in rate of dehydration. Cellulose, extracted from the dice, was examined for crystalline content by water-vapor sorption, X-ray diffraction, iodine adsorption, enzymatic digestibility, and density methods. All methods agreed in showing a higher crystallinity in unblanched than in blanched samples, a continual increase in crystallinity in all samples as storage time increased, and no notable differences in crystallinity as a result of different dehydration rates.

ESSENTIAL OILS

Deterioration of lemon oil. Formation of p-cymene from γ-terpinene, by Ikeda, R. M. *et al.*, *Food Technol.*, 1961, **15** (9), 379.—The formation of p-cymene from γ-terpinene during deterioration of lemon oil was shown. Citral which was suspected as the precursor of p-cymene, was added to orange oil and allowed to deteriorate. No detectable amount of p-cymene was found. γ-terpinene was isolated from lemon oil, and oxidized to p-cymene when exposed to air.

Hydrocarbon composition of lemon oils and its relationship to optical rotation, by Stanley, W. L. and Ikeda, R. M., Cook, S., *Food Technol.*, 1961, **15** (9), 381. —A simple, routine method of separating the terpene hydrocarbon from citrus oils for subsequent gas chromatographic analysis is described. Subinene is identified in lemon oil, and a-thujene is tentatively identified by gas chromatographic retention time. Statistical results of the terpene hydrocarbon analyses of 105 lemon oil samples is reported. A direct relationship between d-limonene concentration and optical rotation and an inverse relation between -pinene concentration and optical rotation were found.

Citrus essential oils, II.—Composition of distilled oil of limes, by Slater, C. A., *J. Sci. Fd Agric.*, 1961, **12** (11), 732.—The composition of West Indian distilled oil of limes has been investigated and compared with that of Mexican distilled oil. Seven substances not previously reported as being present in lime oil have been isolated together with several unidentified compounds.

FRUIT AND VEGETABLE PRODUCTS

Effect of room temperature vs. refrigerated storage on quality of canned fruit and vegetable products, by Brody, A. L. and Bedrosian, K., *Food Technol.*, 1961, **15** (8), 367.—Twenty-six commercially canned fruit and vegetable products were stored at 75-80°F and at 34-36°F to study color and flavor changes during normal and refrigerated storage and to demonstrate subjective changes that may accompany reported nutritive losses. All products displayed some colour and/or flavour changes at the higher storage temperatures; changes were generally significantly slowed by the lower temperatures. Changes observed at 75-80°F storage were very marked quality loss in 10 products: 6 fruit drinks, 2 fruit-pie fillings, 1 fruit, and 1 vegetable product. Four products showed moderate change at 75-80°F; 8 displayed slight changes and 1 was benefited by higher temperature. Differential between rate of chemical reactions at 75-80°F versus 34-36°F determines the amount of benefit obtained from refrigerated storage of these canned foods.

Relationship of fresh clingstone peach colour to colour and grade after canning, by Leonard, S. J., Luh, B. S., Chichester, C. O. and Simone, M., *Food Technol.*, 1961, **15** (11), 492.—The relation of the colour of fresh clingstone peaches to the colour and colour grade of the canned product was investigated. Two varieties of California clingstone peaches were graded into skin and flesh colour groups. Twenty-four hours after being canned, the samples were graded by U.S.D.A. inspectors. The same samples were pulped in a nitrogen atmosphere, de-aerated, and evaluated for colour with the Gardner automatic reflectance colour difference meter. The colour of the fresh peach pulp and canned peach pulp was significantly correlated with the Gardner 'a' values. The relation between the colour of the fresh peaches and the colour and flavour of the canned product is discussed.

FROZEN FOODS

Changes in pH of some frozen foods during storage, by Van den Berg., L., *Food Technol.*, 1961, **15** (10), 434.—Changes in the pH of frozen cauliflower, green beans, tomatoes, cod, haddock, and beef were measured during storage at -10° and -18° C to obtain information on the factors that may affect quality. Changes in pH of 0.3 to 2.0 pH units occurred in all products during the first three months of storage. In cauliflower, green beans, and fish samples, the pH decreased initially (at both -10° and -18°C) but returned to the pre-freezing value (6.0—6.5) after 2-3 months. The pH of tomatoes did not change appreciably at -10°C but increased sharply (1.5 pH units) after 20 days at -18°C, and then returned to its initial value (4.0) 10-20 days later. In beef, the pH increased from 5.6 before freezing to 6.0 immediately after freezing, and then remained essentially unchanged. Changes in pH after three months were small in all products.

MEAT AND FISH

Studies on frozen fish. II. Some chemical changes occurring during frozen storage, by Sawant, P. L. and Magar, N. G., *Food Technol.*, 1961, **15** (8), 347.—The effect of frozen storage and glazes on some chemical changes in fish was studied. Moisture content decreased on storage, whereas total protein nitrogen apparently increased. Total amino-nitrogen decreased. The loss in total amino acids and change in PDR index of fish was observed during frozen storage. The changes mentioned above were slowed by glazes. The ratio of Ba-acetate non-precipitable ribose to total ribose increased during storage. The possible route of formation of Ba-acetate non-precipitable ribose has been suggested.

The effect of internal temperature and time of cooking on the palatability of pork loin roasts, by Webb, N. L. *et al.*, *Food Technol.*, 1961, **15** (8), 371.—How the palatability of pork loin roasts is affected by different internal temperatures and cooking time was determined on 14 pork carcasses in two trials. There were four treatments of cooking pork loin roasts at 176.6°C: to internal temperatures of 85°C (A); 73.9°C (B); 65.6°C (C); and maintained at 65.6°C for one hour (D). Tenderness scores were reduced as the internal temperature was increased, and slightly increased as time was prolonged. Flavour scores increased as internal temperature was increased. Cooking time, drip loss, evaporation loss, and total loss during cooking increased as internal temperature and cooking time were increased. There were no significant differences in carving losses due to differences in internal temperature or cooking time.

Microbial analysis of frozen raw and cooked shrimp. I.

General results, by Silverman, G. J., *Food Technol.*, 1961, **15** (11), 458.—Ninety-one samples of commercial frozen shrimp were analyzed for total bacterial count, coliforms, coagulase-positive staphylococci, and members of the Salmonella-Shigella-typhoid groups. The samples consisted of raw or cooked shrimp that had either been breaded, shelled or left unshelled. Total bacterial counts ranged from 50 organisms per gram to over 9,000,000 per gram. There appeared to be little correlation between total plate counts and coliform counts except for the pre-cooked samples, in which both were low.

Seventy-five per cent of the frozen shrimp samples contained coagulase-positive staphylococci, present as a small percentage of the total microbial flora.

Isolates from one sample were strongly positive to Salmonella polyvalent sera, and four were weakly positive. Reactions on differential media indicated that Shigella organisms might be present in 16 samples.

Microbial analysis of frozen raw and cooked shrimp. II. Certain characteristics of staphylococcus isolates, by Silverman, G. J. *et al.*, *Food Technol.*, 1961, **15** (11), 458.—Several techniques were compared for their ability to isolate coagulase-positive staphylococci. Selective enrichment involving inhibition of competing organisms by 10 per cent NaCl followed by selection from mannitol salt agar or by their ability to produce halos on Tween 80, and egg yolk agars, was compared with direct plating on these same differential agars. Since coagulase-positive staphylococci were present in frozen shrimp as a small percentage of the microbial population, isolation by selective enrichment was much more successful.

In 91 samples tested, 68 were found to contain these organisms, and in every case where they were present, selection of colonies, pigmented or/and non-pigmented by a positive halo reaction, appeared to be sufficient for detection.

A formulation containing Tween 80 was compared to egg yolk medium for the detection of coagulase-positive staphylococci. Of 41 samples examined, 33 yielded coagulase-positive staphylococci with the egg-yolk medium and 32 with the Tween 80 medium. Pigmentation was superior on egg yolk agar although halo formation was equally distinct for both.

A total of 209 isolates of coagulase positive and coagulase-negative organisms were obtained. These cultures were examined for the presence of bound coagulase and for phage types. Bound coagulase was closely associated with free coagulase and could profitably be incorporated as a screening procedure. Phage typing was obtained, except with one coagulase-negative culture, only on coagulase-positive isolates, although only approx 35 per cent of the strains were typable. The lytic spectra indicated that certain of the coagulase-positive staphylococci isolated in this investigation were related to groups associated with food intoxication or with infectious outbreaks.

MICROBIOLOGY

Comparison of four methods of isolating *Salmonellae* from foods, and elaboration of a preferred procedure, by Montford, J. and Thatcher, F. S., *Food Sci.*, 1961, **26**, (5), 510.—From comparative study of four methods of isolation of Salmonella from egg products, of six enrichment broths and five selective media, and of several secondary technical operations a recommended scheme for isolation of salmonellae from foods was devised and shown to be effective for diverse foods containing as few as 0.15 salmonellae per g. even in the presence of extreme coliform and other bacterial contamination.

Spoilage control in mixed feeds, by Richardson, L. R. and Webb, B. D., *Cereal Sci. Today*, 1961, **6** (8), 260.—Two methods are described for evaluating critical moisture conditions for the storage of feed ingredients and mixed feeds. Moisture content was used in one method and interparticle-air relative humidity in the other. Moisture content was satisfactory for predicting moisture conditions safe for the storage of individual ingredients, but it was unreliable for mixed feeds. On the other hand, interparticle-air humidity, as measured by an electric hygrometer and humidity sensing element, was reliable for both ingredients and mixed feeds. Safe moisture contents varied from 8.7 per cent for bonemeal to 17.0 per cent for distiller's dried grains, but a safe humidity was constant for either ingredients or mixed feeds. No mold growth or heating occurred during a 6-week storage period when the humidity was 72 per cent or less, provided the humidity was measured at the same temperature as that at which the feed was stored.

Three or four lots of feeding cane molasses containing 26 and 28 per cent moisture increased in moisture and decreased in Brix and total sugar when the samples were stored at 37°C for 18 weeks. Practically no changes occurred in any of the dilutions when the molasses was stored at 6°C. Similarly, no changes occurred at either storage temperature when the moisture content was 25 per cent or less.

Propionate was more effective as a mold inhibitor when it was added to a high-moisture ingredient, such as cane molasses, at pH 3.0 before it was mixed into the feed than when it was added to a high-moisture ingredient at a neutral or alkaline pH or when it was added directly to the feed mixture.

Survival of bacteria of public health significance in frozen sea foods, by Raj, H. and Liston, J., *Food Technol.*, 1961, **15** (10), 429.—In frozen processed foods stored at 0°F for periods up to 648 days, total viable counts at 68° and 95°F showed less than a tenfold decrease, coliform count declines comparably in uncooked samples but more steeply in pre-cooked samples, and enterococci showed fluctuations but little or no new decrease in either type of sample. Studies of the effects of freezing (-30°F) and storage at 0°F on six selected species of micro-organisms associated directly or indirectly with potential food-poisoning hazards showed that in brain heart infusion broth suspensions, after 393 days at 0°F, *Salmonella typhimurium* was virtually eliminated, *Escherichia coli* and *Staphylococcus aureus* were greatly reduced in number, *Streptococcus pyogenes* counts were slightly reduced, and *Streptococcus bovis* and *Clostridium perfringens* were little affected. When suspended in sterilized fish homogenate (FH), *S. typhimurium* and *S. aureus* were reduced tenfold in 393 days at 0°F, while the rest of the cultures were not significantly affected.

Simultaneous studies of the effects of multiple cyclic defrosting showed that in broth suspensions, *S. typhimurium* and *E. coli* were virtually eliminated after the third and fourth cycle, respectively. *S. aureus* and *S. pyogenes* were reduced ten-thousand fold and seventy fold respectively, after the fifth cycle and *S. bovis* and *C. perfringens* were little affected by five cycles. In FH, *E. coli, S. aureus*, and *S. typhimurium* survived through the fifth cycle in numbers sufficient to constitute a public health hazard. *S. pyogenes, S. bovis*, and *C. perfringens* were little affected under similar conditions. The pure-culture studies thus confirmed the protective effect of sea-food materials against bacteria, and provide a partial explanation of the findings with commercially prepared frozen sea-foods.

SPICES

Volatile constituents of black pepper, by Jennings, W. G. and Wrolstad, R. E. *Food Sci.*, 1961, **26** (5), 499.—Black pepper oil, separated by gas chromatographic techniques, had at least 23 volatile components. On the basis of relative retention volumes and infra-red spectroscopy, these include -pinene, -pinene, D-limonene, and -caryophyllene. -Phellandrene, reported by others, was not detected. Four samples of pepper oil differed in the relative amounts of various constituents. The methods described permit rapid screening of samples, and selection for greater flavour uniformly from batch to batch.

TECHNOLOGY

Variations in heat treatment of individual product particles in plate heat exchangers, by Dunkley, W. L., Watson, E. L. and McKillop, A. A., *Food Technol.*, 1961, **15** (9), 400.—Variation in heat treatment of individual particles during processing of certain foods is important in relation to destruction of enzymes and micro-organisms, and changes in flavour, colour, or physical properties of the product. Possible extremes of heat treatment during processing in three plate heat exchangers were evaluated. The results were markedly influenced by the sensitivity of methods of detecting the slowest and fastest particles. Conductivity test for residence times detected variations of heat treatment of about three fold in a small proportion of the test fluid in two of the exchangers, and a motion picture procedure showed a similar range in one unit. Other evidence indicated that small amounts of fluids received much greater variations in heat treatment, especially under unfavourable conditions of equipment operation. Fastest and slowest particles are necessarily defined arbitrarily on the basis of the sensitivity of the measuring system, and hence may imply unwarranted confidence in the lethality of heat treatment of the fastest particles. Design and operation of plate heat exchangers should avoid low-velocity zones and air-pocket formation, since these may contribute to fouling of heat-transfer surfaces, build up of thermofolic organism, and flavour damage to the product.

Studies in canning processes. IV. Lag factors and slopes of tangents to heat penetration curves for canned foods heating by conduction, by Cowell, N. D. and Evans, H. L., *Food Technol.*, 1961, **15** (9), 407.—The lag factor *j* and slope *f* of the asymptote to heat penetration curves are important parameters in process calculations. Since in practice the asymptote is not known these parameters are obtained from a tangent drawn to the heating curve. The values of these parameters for the tangent may differ appreciably from those of the asymptote, the difference depending on the ratio of can height to can diameter and the posititon on the heating curve at which the tangent is drawn. Curves are given showing these effects.

Parboiling characteristics of California medium-grain rice, by Mecham, D. K., Kester, E. B. and Pence, J. W., *Food Technol.*, 1961, **15** (11), 475.—To define conditions under which Calrose rice, a medium-grain California variety, could be parboiled satisfactorily, rough rice was subjected to various soaking, holding (tempering), and cooking treatments.

During soaking, the rates of water uptake at both 132° and 150°F differed among 5 lots. The total water content required and the time needed for distribution of water through the kernel to provide for gelatinisation of soft granules in the centre of the kernel upon cooking, also differed.

Certain consistent features appeared, however. When more than above 37 per cent water content was reached rapidly, for example, by soaking under reduced pressure, combined soaking and tempering time could generally be relatively short (minimum about 2 hours) at both 132° and 150°F. With low water content down to about 30 per cent, total soaking plus tempering times had to be increased; and as either temperature or water content was reduced, the required time increased rapidly. Soaking at temperature much above 150°F caused some kernels to burst and the mass of rice to become sticky and slimy because of starch gelatinisation.

With properly soaked rice, gelatinisation of starch throughout the kernels was obtained by cooking 5 min. at 20 lb. per sq. in. gauge pressure or 8 min. at 10 lb. Results were also satisfactory with cooking at 30 and 40 lb. for shorter times, but at these higher pressures over cooking quickly caused the product to darken.

Improper soaking and inadequate cooking resulted in complete gelatinisation, and high proportions of broken kernels in the dried and milled product. Before processing, the five lots of Calrose rice yielded 71-74 per cent milled rice and 48-65 per cent head rice (unbroken kernels). When properly parboiled the yields were 73-78 per cent milled rice and 66-76 per cent head rice.

Studies of the smoking process for foods. II. The role of smoke particles, by Foster, W. W. *et al.*, *J. Sci. Fd. Agric.*, 1961, **12** (9), 635.—Wood smoke consists of two discrete phases, a disperse, a disperse liquid phase—smoke particles—and a dispersing gas phase—smoke vapours. These phases constitute a partition system, individual smoke constituents being distributed between them according to their respective partition coefficients, following Nernst's law. When the partition equilibrium is disturbed, e.g., by diluting the smoke with air or by scrubbing out smoke components from the vapour phase, or when the partition coefficients are changed, e.g. by raising the temperature, a transfer of smoke constituents from the disperse liquid to the vapour phase occurs. This results in a change in the relative mass concentration of individual smoke constituents in the vapour phase, the vapours becoming relatively richer in non-volatile and poorer in volatile smoke components. Since the rate of absorption of smoke compounds by water is proportional to their mass concentration in the vapour phase these changes in vapour composition are reflected in changes in the composition of the smoke deposits.

VITAMINS

The distribution of thiamine and ascorbic acid in the potato tuber, by Mudambi, S. R. and Hanning, F., *Food Sci.*, 1961, **26** (5) 492.—Two zones that together approximate the cortical layer of two varieties of stored potatoes were compared in thiamine and total ascorbic acid content with the centre region. In both varieties the cortical layer contained a slightly higher concentration of thiamine than the centre. In Sebago but not in Russet Burbank, total ascorbic acid was higher in the cortical region. The components of total ascorbic acid were determined separately in the Russet Burbank variety. The biologically, active fraction (reduced and dehydroascorbic acid together) constituted 90-97 per cent of the total ascorbic acid.

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AMINO ACID COMPOSITION OF GROUNDNUT PROTEIN ISOLATES

By M. N. Satyanarayana, M. V. L. Rao, M. Srinivasan, A. Sreenivasan and V. Subrahmanyan

(*Central Food Technological Research Institute, Mysore*)

Processes for the production of protein isolates from whole groundnut kernel and edible quality screw-press cake have been developed at this Institute[1,2,3]. In the ultimate choice of optimal processing procedures, their influence on the physico-chemical properties, amino acid make-up and nutritive value of the isolates are considerations of major importance. Eapen and Kalbag[4] have studied the physico-chemical aspects of some of the operations in the integrated process for groundnut with particular reference to the denaturation of the protein. Subramanian *et al*[5]. have examined the effect of the different methods of drying on the solubility and nutritive value of the final isolates from screw-press cake. Complementary to these investigations, the essential amino acids content of these isolates was determined. The results are presented in this communication.

Experimental

Materials: The following protein sources and the isolates obtained from them by various procedures and methods of drying were used:

1. Groundnut kernels extracted in a soxhlet apparatus in the laboratory with petroleum ether.
2. Edible quality press cake extracted in the laboratory with petroleum ether.
3. Protein isolate from kernel prepared according to the integrated process and air-dried at 55°—60°C.
4. Protein isolate from press cake, and air-dried at 55°—60°C.
5. Protein isolate as in (4), drum dried at 60 psi steam pressure, temperature 95°C, and
6. Protein isolate as in (4), toasted at 115°C for 15 minutes.

The isolates (4), (5) and (6) are the same as the preparations, A, B and D used by Subramanian *et al.*[5] in their nutritional studies.

Methods: The isolates and protein sources were hydrolysed with 20 volumes of 3 N HCl for 10 hrs. at 15 psi. steam pressure in an autoclave. The hydrolysates thus obtained were concentrated *in vacuo* and neutralized to pH 6.5—6.8. The concentrates contained 1.2—1.5 mg N/ml. 15 μl of the concentrates were used for the paper chromatographic estimations.

The two-dimensional buffered paper chromatographic procedure of Subramanian and Rao[6], using phenol—pH 1.0 (HCl-KCl) buffer and butanol: acetic acid: water (4:1:1) solvent systems was employed for the estimation of the various essential amino acids. In addition, the values for certain acids wer checked by the following buffered systems of McFarren[7]:

(*a*) Phenol—pH 12.0 for threonine

(*b*) Benzyl: butyl alcohol (1:1)—pH 8.4 for leucine and isoleucine.

(*c*) Butanol: acetic acid: water (4:1:1) pH for cystine and methionine.

The values for the basic amino acids were also checked by column chromatography on Amberlite IR-120 resin, according to the procedure of Moore, Spackman and Stein[8]. The values thus determined agreed to within 10 per cent with those obtained by paper chromatography, as is evident from the data in Table I. Tryptophan was estimated by the colorimetric procedure of Spies and Chambers[9] using p-dimethyl-amino-benzaldehyde reagent.

The final values presented in Table II are the averages of those (3—4 independent determinations by the paper chromatographic methods and duplicate runs by column chromatography) obtained for each amino acid by the various procedures adopted.

TABLE I. *Content of basic amino acids in groundnut protein isolates estimated by two-dimensional buffered paper chromatography (P) and column chromatography (C)*

(g. amino acid/16 g. N)

Amino acids	Kernel defatted		Cake defatted		Isolate from kernel (integrated process) air dried at 55-60°C		Isolate from cake, air dried at 55–60°C		Isolate from cake drum dried (60 psi· steam pressure 95°C)		Isolate from cake toasted at 115°C for 15 min.	
	C	P	C	P	C	P	C	P	C	P	C	P
Lysine ...	3.9	4.1	4.0	3.8	3.5	3.9	3.6	3.6	3.9	3.5	3.0	3.2
Histidine ...	2.5	2.3	2.0	2.2	2.3	2.5	2.4	2.2	2.2	2.4	2.1	2.3
Arginine ...	9.6	10.4	9.2	10.0	11.4	10.4	11.0	10.6	10·5	11.0	10.6	10.2

P: The figures represent the average of 3-4 independent determinations.
C: The figures are the mean of duplicate estimates.

TABLE II. *Essential amino acids content of groundnut protein Isolates*

(g. amino acid/16 g. N)

Amino acids	Kernel defatted	Cake defatted	Isolate from kernel (integrated process) air dried at 55-60°C	Isolate from cake air dried at 55–60°C	Isolate from cake, drum dried (60 psi. steam pressure, 95°C)	Isolate from cake toasted at 115°C for 15 min.
Cystine ...	1.4	1.4	1.5	1.3	1.4	1.1
Methionine ...	0.9	0.9	0.8	0.9	0.9	0.9
Lysine ...	4.0	3.9	3.7	3.6	3.6	3.1
Histidine ...	2.4	2.1	2.4	2.3	2.3	2.2
Arginine ...	10.0	9.6	10.7	10.8	10.3	10.4
Threonine ...	2.5	2.5	2.2	2.4	2.5	2.4
Valine ...	3.3	2.8	3.3	3.1	3.2	3.0
Phenylalanine ...	4.3	4.2	4.8	4.4	4.6	4.2
Leucine ...	4.9	4.8	4.9	5.2	5.6	4.9
Isoleucine ...	2.9	3.0	2.7	3.2	3.6	3.4
Tryptophan ...	0.85	0.82	0.80	0.79	0.76	0.78

Results and Discussion

Table I shows that there are no significant differences in the content of essential amino acids between the protein isolates from the press cake air-dried at 55-60°C and drum-dried, nor between these and the proteins as present in the fat-free cake. The same is true of the protein isolate produced from the kernel by the integrated process as compared with the kernel. Some of the minor differences are ascribable to the presence of 10 per cent of the nitrogen in the kernel and cake in the form of non-protein nitrogenous substances, which include some amino acids also.

As contrasted with the air-dried and drum-dried preparations, the isolate toasted at 115°C shows a lower content of certain amino acids. The lowering in cystine, lysine and leucine is about 14 per cent. The changes in some other acids are even much smaller. The lower content of lysine has to be reckoned with as it is one of the limiting amino acids in groundnut proteins. However, the biological assay data of Subramanian *et al*[5]. show clearly that these preparations do not significantly differ in their nutritive values as judged by their protein efficiency ratios and net protein utilization values. Nevertheless, they point out that "the diet intake and gain in weight of animals on the toasted protein diet are, however, slightly more throughout the experimental period". Presumably, the higher intake in these experimental studies has compensated for the slightly lower content of lysine and certain other essential amino acids in the protein isolate. In any case, the changes observed in amino acid composition are of a small order and appear to support fully the results of biological evaluation.

The results are in agreement with the conclusions of earlier workers that only when groundnut proteins are subjected to drastic heat treatment, there is destruction of amino acids and consequent impairment in biological value[10-15]. They also show that the processing conditions employed for the production of the above isolates are far less drastic than those of Lord and Wakelem[16] who observed a breakdown and destruction of sulphur-containing amino acids which resulted in a significant diminution in nutritive value[17].

Summary

The essential amino acids content of protein isolates from groundnut kernel and edible quality press cake subjected to various methods of drying have been determined by chosen procedures of paper and ion-exchange column chromatography. The results have shown that there is no significant change in the amino acid make-up of the proteins, though toasting at 115°C lowers the content of lysine, leucine and cystine to some extent (about 14 per cent). The results are in consonance with the biological values of the preparations already reported from this Institute and the findings of earlier workers.

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STUDIES ON REFINING OF MILLET FLOURS—I. RAGI (Eleusine coracana)

By P. P. Kurien and H. S. R. Desikachar

(Central Food Technological Research Institute, Mysore)

Ragi (*Eleusine coracana*) a grain of considerable importance in south India—especially in Mysore state, is unique among the cereals in containing a high percentage of calcium (0.35 per cent). It has, however, been shown that the availability of the calcium as also the protein is very low, presumably due to the high amount of roughage in the grain[1,2,3]. Kurien *et al*[4]. found that the millet contains about 15 per cent husk which accounts for about 50 per cent of the calcium, 30 per cent of the protein and 15 per cent of the phosphorus of the whole grain. It was found that in attempting the removal of husk by grinding the soaked grain and sieving, a large amount of the nutrients was lost as water solubles.[4] The residue thus obtained contained only 37, 14 and 30 per cent of the total protein, calcium and phosphorus respectively of the whole grain. A method of obtaining a refined *ragi* flour containing maximum amount of the nutrients and negligible amounts of skin coat by a method of dry milling after suitable conditioning was, therefore, attempted next.

In preliminary trials, the grain was moistened with 3 to 7 per cent moisture, equilibrated for about 2 hours, ground several times (Wiley mill) and sieved between each operation. The first fraction was light coloured, while subsequent fractions contained increasing amounts of the husk. A method to toughen the husk in order to prevent its dis-integration was, therefore, necessary. The following method of hot-conditioning was adopted after various trials and was found to give a flour with minimum husk.

The moisture content in the grain (original 11 per cent) was increased by mixing with 5 per cent extra water and after steaming for various periods, cooled to room temperature and immediately milled, using first a 2 mm. sieve. The ground product was passed through a 60 mesh sieve and designated fraction I. The residue was again disintegrated in the same mill using 1 mm. screen and after passing through 60 mesh, fraction II was obtained. The residue (+60; stage II) was highly coloured and contained major portion of the husk. A steaming period of 2 minutes gave the best results since the yield of flour was maximum (fraction I, 35 per cent and fraction II, 34 per cent). About 70 per cent of the grain was thus recovered in the form of a flour with minimum husk. Fractions I and II as also the combined lot were analysed for protein, calcium, phosphorus and thiamine. The results, given in Table I, show that fraction I comprising the inner core of the grain is mainly starchy and low in protein. Fraction II derived from the endosperm layers nearer to the outer husk contains a larger amount of the nutrients.

Table I. *Composition of various fractions from dry and wet milling process*

Components	Whole grain	Fraction I	Fraction II	Combined fractions	Fraction from wet-processing of residue
Protein ($N \times 6.25$)%	7.2	3.6	9.1	6.1	8.4
Calcium (mg)% ...	359	215	267	230	133
Phosphorus (mg)%	211	36	237	127	338
Thiamine (μg)% ...	550	...	...	720	...
Crude fibre% ...	2.6	0.19	0.57	0.38	0.34

The residue (+60; stage II) could not be put through the same process further, as the husk tended to get powdered. It was, therefore, subjected to a process of wet milling to recover the edible matter from it. It was soaked in water for 2-3 hours, homogenised in Waring blendor and sieved through a 60 mesh sieve. The process was repeated on the residue retained on the sieve. The combined milk was centrifuged at 2000 r.p.m. and the starchy sediment dried. Whole *ragi* soaked in water for 24 hours was also wet-processed as above and the comparative data for wet processing of whole *ragi* as against dry milling followed by wet processing of the residue are presented in Table II. Between the wet milling and the dry milling procedures, the wet milling process no doubt gives a higher yield of flour but recovery of nutrients is much lower as compared with the dry milling process as a result of loss of the solubles. Dry milling recovers nearly 90 per cent of the thiamine of the whole grain and also more of protein, calcium and phosphorus. The yield of flour is about 70 per cent, but if the residue from the process is further wet-processed, 12 per cent more of the edible matter can be recovered. The above method of dry milling, after heat conditioning of the grain, has also been applied to the preparation of malted *ragi* flour. The complete absence of fibrous husk, is to be ensured in such a product, keeping in view the known use of malted *ragi* in infant and invalid foods.

TABLE II. *Per cent extraction of nutrients by wet and dry milling of ragi*

	Wet milling	Dry milling	Dry milling followed by wet processing of residue
Total yield	81	70	82.5
Protein	37	54	74.2
Calcium	14	45	49.5
Phosphorus... ...	30	42	62.2
Thiamine	13	91	...

The comparative economics of the process for preparation of refined raw or malted *ragi* flours by the above methods is being studied with larger batches.

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Technical Seminars

THE Seminar which is a regular scientific activity of the CFTRI provides an open forum for all scientific workers of the Institute in so far as one of them presents a paper on a problem on which he is engaged or reviews an aspect of Food Science and Technology, while others participate in the discussion and express their views on the subject matter of the paper. The visits of distinguished scientists and technologists are also made use of for arranging addresses to such gatherings. Summaries of the Seminars held during January and February, 1962 are given in this section.

S (*IS*) 10

Packing and transport of perishable foods II—potatoes, by H. B. N. Murthy (*January* 12, 1962).—The speaker reported observations made on a consignment of 30 tons of potatoes from Hassan to Calcutta. During the journey of 1385 miles which was of twelve days duration, observations were made, among others, on the build-up of temperature, humidity and carbon dioxide, relating to handling while loading, transhipment and unloading, type of transport used, factors influencing the duration of the journey etc.

About 3 tons of the consignment was used for carrying out studies on different types of packages and also on the effect of various pre-treatments. In addition to the conventional jute bag, the following packages *viz.*, wooden crates, bamboo baskets, polyethylene lined jute bags and the conventional bag which was given more aeration by removing some threads in the warp direction were also used. Pre-treatments such as, sprout inhibitors, washing with water and chlorine water containing 100 ppm. of available chlorine were also included in the study.

The results indicate that among the packages tried, wooden crates appear to be the best since they provide mechanical protection as well as ventilation for the product. However, in view of the cost of the crate, high tare weight and lack of mechanical handling facilities, wooden crates may not be found feasible under the present circumstances. No significant difference was observed between conventional jute bag and the aerated bag or polyethylene lined bag. Since the aerated bags are cheaper than the conventional bags it would be worthwhile carrying out large-scale trials to find out the relative efficiency.

Different methods of pre-treatment generally did not show any significant difference in percentage spoilage, since in general in the consignment under study the spoilage was very low and there was no visible sprouting.

The build-up of temperature and humidity inside the wagon was not significantly different from the ambient conditions which prevailed during the course of the journey. This may be due to the low respiration rate of potatoes.

In the absence of mechanical handling devices, liberal use is made of hooks by the porters to handle bags which result in considerable damage to the tuber. The four corners of the bag should be so made as to provide ears for handling the bags. The damage caused by abrasion with the metallic projections in the walls of the wagon could be minimised by the use of bamboo mat liners and suitable dunnage. The use of louvered wagon appears to be advantageous for transport of perishables. The wagons should preferably be painted outside with aluminium paint.

The total transportation time is governed by factors such as transhipment from meter gauge to broad gauge, reformation of wagons at marshalling yards and time taken for repair of wagons found defective *en route*. If care is taken to avoid delay at the above points, the transportation time will be minimum, thus reducing the chances of spoilage.

The talk was supplemented by (Major) N.V.R. Iyengar and Dr H. C. Srivastava. It was then followed by a discussion in which among others the following points were raised:

Build up of high temperature on top of the bags inside the wagon, effect of high ambient conditions on rate of spoilage, influence of the type of paint on the temperature inside the wagon, use of louvered wagons, use of mesh bags and insecticide treated bags, possibilities of bulk transport, necessity for vents in the polyethylene liner, grading difference, taste-acceptability between Coonoor and Hassan varieties etc.

The President in his concluding remarks stressed the need for further well planned large-scale trials. He was of the view that a study of this type should be replicated using automatic recording equipment. He also stressed that more data should be collected in louvered type of wagons.

S (*IS*) 11

Studies on the preparation of insecticidal clays. By K. Krishnamurthy (*January* 31, 1962), —Reviewing the work on the use of inert dusts by various workers, Dr Krishnamurthy pointed out that no systematic study was carried out with a view to evaluating the various inert dusts proposed and employed for their insecticidal action under similar and standard conditions.

The speaker then described the technique standardised for evaluation of the insecticidal activity of various materials and gave an account of the results of the preliminary screening studies with a number of minerals, raw clays, activated clays, decolorising and gas adsorbing carbons. He pointed out that, in general, minerals having hardness number of 4 and above in Moh's scale, showed some insecticidal activity while gas adsorbing and decolourising carbons and activated clays displayed much more insecticidal activity than their hardness number would suggest.

Narrating the studies conducted with various raw clays in order to produce highly insecticidal material, he pointed out that: (*i*) the raw clays showed poor insecticidal activity, (*ii*) in general, the insecticidal activity of the raw clays increased to some extent on heating at 400° C, (*iii*) acid activation enhanced the insecticidal activity tremendously (in some cases, the increase was 300 times), (*iv*) post activation heat treatment increased the insecticidal activity still further, (*v*) methylene blue absorption capacity or the base exchange capacity decreased on acid activation, and (*vi*) clays having either kaolin or montmorillonite group of minerals predominantly, could be activated for their insecticidal potency.

The speaker then referred to the studies on the evaluation of commercial bleaching earths for their insecticidal action and pointed out that many commercial bleaching earths showed insecticidal action while few of them showed a very high activity. However, even though some clays exhibited high bleaching action, they showed comparatively low insecticidal activity. The results indicated that (*a*) the bleaching property is not an index of insecticidal activity of all earths even though it is so for the majority of the clays and (*b*) the activation treatments needed to get maximum bleaching property and maximum insecticidal activity appear to be different.

The speaker then reported the results of studies with selected number of clays on the relationship between the increase in the insecticidal activity of the clays and other characteristics such as bulk density, base exchange capacity, adsorptions of moisture, CCl_4, I_2, methylene blue and malachite green. He pointed out that the activation resulted in (*a*) decrease in bulk density, (*b*) decrease in malachite green, methylene blue absorptions and base exchange capacity, and (*c*) increase in CCl_4, I_2, adsorptions and moisture absorption. The clays which show high methylene blue adsorption *i.e.*, which have more montmorillonite groups of minerals, exhibited on activation, high moisture absorption capacity, while clays having predominantly more of kaolin groups of clay minerals showed less moisture absorption but high insecticidal properties. As it is desirable to use clays which absorb less moisture from the atmosphere as insecticides, clays having more kaoline minerals have to be preferred for activation purposes to those having more of montmorillonite minerals.

Next the speaker described the studies carried out in detail on the activation of typical kaolinic clay obtained from Bageshapura. The clay was activated with HCl and H_2SO_4 varying the normality, time and pressure of reaction. The results of the studies showed: (*i*) both HCl and H_2SO_4 could be used for activation, (*ii*) increase in normality, hours of heating and pressure of reaction generally brought about an increase in the insecticidal activity and progressively changed other characteristics like bulk density, MB absorption and bleaching property showing that there is a correlation between the insecticidal activity and other characteristics when a particular sample of clay is taken for consideration, (*iii*) insecticidal activity increased gradually to a maximum and decreased as the activation treatment increased, (*iv*) the activation treatments necessary to produce maximum insecticidal activity and maximum bleaching activity were different, (*v*) after activation the clay which was not washed free of acid did not show insecticidal activity, and complete washing of acid from the activated clay resulted in maximum activity, and (*vi*) heating the acid activated clay at 400°C for 3 hours enhanced insecticidal activity but heating beyond 400°C did not show further improvement.

In conclusion the speaker stated that: (*i*) highly insecticidal material could be produced from inert clays by acid activation, (*ii*) clays rich in kaolin minerals are to be selected in preference to those rich in montmorillonite minerals for activation, and (*iii*) optimum activation needed to produce maximum insecticidal activity is different from that needed to produce maximum bleaching property.

Supplementing the talk, Shri S. K. Majumder said that the data presented by Dr Krishnamurthy were a part of the programme of work on the use of clay as insecticide and that the data obtained on the mode of insecticidal action of the activated clays would be presented by Smt. Krishnakumari at a later date. He stated that the activation treatment of the clay resulted in its highly sorptive nature for the cuticular lipoid. The removal of the lipoid from epicuticle served as a pre-disposing factor for bringing about mortality of test insects by loss of moisture from the body. The rate of the moisture loss depended on the degree of unsaturation with respect to the relative humidity of the atmosphere. Although gas absorbing carbon, silicagel and montmorillonite or (bentonitic) clay were initially good for insecticidal activity, they absorbed moisture on storage and lost the insecticidal activity considerably. Referring to the practical application of the clay, he stated that acid activated kaolinic clay was more suitable as it did not absorb moisture from the atmosphere and did not bring about high microclimate relative humidity during exposure of the insect which occurred with carbon and silicagel. The activated clay will be used as insecticidal prophylactic dust on the surface of bag stack in conjunction with fumigation treatment.

Shri Majumder then said that clays are mined for ceramic, refractory, textile, bleaching and other purposes. Each mineral group of clays is used for specific purposes such as illite for oil and refractory, kaolin for ceramic and montmorillonite for bleaching. He added that kaolin is nearest to the requirement of insecticidal dust but not the ideal one. There should be an adsorptive property of the dust selectively for lipoid with microcapillaries, like gas carbon and it should also be hydrophobic in nature. It could be obtained by a suitable minerological blend which would require a wide and intensive investigation in collateral fields.

The talk was followed by a discussion in which the following points were raised: relationship of the hydrogen ion in the clay and also the base saturation capacity of insecticidal clays, effects of steam activation and other activation treatments, moisture absorption and insecticidal activity of the clay, methods of application, correlation of different characteristics with insecticidal activity of the clays, combined effect of insecticide and activated clays on insects.

Answering the questions, Dr Krishnamurthy said that most of the cations of the clays were replaceable by hydrogen ion during acid activation treatment. The base saturation capacity could also be studied with reference to the base exchange capacity of the samples Referring to the methods of activation, he said that out of the methods of activation tried, such as heat activation and acid activation, maximum insecticidal activity could be obtained in the kaolinic clays by sulphuric acid activation, leaching the acid thoroughly and subsesequently heating the clay at 400°C. All the activated clays did not directly indicate a correlation with the physical properties such as gas adsorption, oil bleaching, etc., but when a particular clay sample was taken into account a correlation of the physical characteristics could be obtained with the insecticidal activity as was exemplified with Bageshapura clay. He further stated that moisture played a critical role on the insecticidal activity of the clays. Samples of clays with high moisture absorbing capacities lost the insecticidal potency on storage. Referring to the combined effect of insecticides and activated clays, it was pointed out that DDT along with activated clays, was tried on *T. castaneum* and no synergestic effect could be demonstrated and further studies were in progress in this line.

The Chairman, Dr A. Sreenivasan, in his concluding remarks emphasised that insecticidal activities of the clays might have been due to the combined effects of different factors. These factors should be studied thoroughly and the related mode of action taken as a criterion for further screening. He indicated that it was desirable to make detailed studies with a particular geo-chemical type of clay with special reference to the insecticidal effect in relation to its mode of action.

S (*IS*) 12

Some aspects of cultivation of *Pleurotus* sp. by Miss Zakia Banu (*February* 16, 1962).—Mushroom in its restricted sense refers only to the fungus *Psalliota campestris*, the common field mushroom, but in its wider and scientific sense it may mean a fleshly fungus belonging to class *Basidiomycetes*. All the higher fungi including mushrooms should be considered as one of the potent natural sources of food since they have the ability to utilize nutritionally valueless substances like saw dust and paddy straw and grow into good proteinous fatty foods.

In India, the cultivation of mushrooms has been confined to paddy straw mushroom. It is recorded that over 1000 species of mushrooms grow during rainy season and several of them are eaten by the villagers. A general survey of the varieties of mushrooms available around Mysore was made and 15 edible and 5 poisonous varieties were collected. Among them *Pleurotus* sp. was found to be eaten by many people and since it appeared to be a new species, studies to standardise its cultivation were undertaken.

For the preparation of spawn of *Pleurotus* sp. different media were tried *e.g.*, paddy straw, saw dust, *ragi* and *jawar* grains etc. Paddy straw spawn gave the best yield. It was found that the addition of extra nutrient *e.g.*, oat meal to the spawn did not result in good yield. Storage of spawn at low temperature adversely affected its viability. With the increase of storage of spawn at room temperature, the yield decreased. Maximum yield was obtained in 4 months old spawn kept at room temperature.

For the cultivation of *Pleurotus* sp. a number of media were tried *e.g.*, paddy straw, jawar straw, hard and soft saw dust, rice hulls, horsedung manure and their different combinations. Paddy straw bed gave the best yield. With the increase in the quantity of straw per bed, it was found that there was an increase in the yield up to a certain extent, after which it decreased. This may be due to the ramification of mycelium over a large area with limited nutrients thus adversely affecting the fructification.

Powders of low quality cereal grains and pulses were tried as a source of nutrients at the rate of 2 per cent of the straw used for the bed. The commodities tried were *ragi*, *jowar*, barley, wheat, *bajra*, oat, Bengal gram and red gram. There was a noticeable increase in the yield when oat meal, red gram or Bengal gram dhal powder was used. Since the use of oat meal is expensive, addition of red gram dhal was preferred. It was also found that use of 1 per cent superphosphate along with red gram gave a higher yield, while $(NH_4)_2SO_4$ and urea when used as a source of nitrogen had no favourable effect on yield. The first crop generally appears 15 days after the inoculation and the second crop at the interval of 1 or 2 weeks after the first harvest. Bottled spawns along with instructions for cultivation were supplied to various parties, and the reports so far received showed that this variety of mushroom could be cultivated over a wide range of temperature and humidity.

After standardising the conditions for cultivation, large-scale trials were conducted to work out the rough economics, which indicated that it needs a fair trial in different parts of the country.

The harvested fresh mushroom can be cooked or processed on a number of ways as any vegetable. It was found that among various methods of dehydration, sponge dehydrated mushrooms were the best in their flavour and capacity for reconstitution. The frozen mushroom kept well for one year. Among canned mushroom, it was found that addition of 0.3 per cent monosodium glutamate improved the flavour.

The talk was then followed by an interesting discussion in which the points raised related to: colour *vs* poisonous character, chemical nature and pH of poisonous varieties, use of rice bran along with paddy straw, the reason for not getting higher yield in relation to further increase of spawn per bed, effect of storage of mushrooms on flavour and nutritive value, information about Russian varieties of mushrooms, pests of mushrooms, whether the yield of second crop could be improved, expressing the yield on dry weight basis, possibilities of export and limitations of large-scale cultivation; use of cellulose decomposing organism, correlation between nutrients supplied and yield and extraction of protein and mineral from spent straw.

The speaker and Dr Srivastava answered the questions. They remarked that the chemical nature of poisonous variety is due to the presence of an alkaloid *e.g.*, Mascarine with high nucleolytic and haemolytic activity as well as the presence of high percentage of zinc in some of the typical varieties. There was no difference in pH between edible and poisonous varieties found around Mysore. Colour should not be taken as the only criterion to differentiate between edible and poisonous varieties as a few edible varieties are also slightly coloured. Rice bran along with straw was also used with no effect, probably because of high FFA; it was found that the quantity of inoculum more than the optimum would adversely affect the formation of deploid mycelium and chlamydospores thus decreasing the final yield. The speaker stated that storage and nutritive studies were in progress and would be reported later. As regards pest infestation, it was observed that so far no pests were noticed on this variety of mushroom but *Sciara* flies, *Phorid* flies and spring tails have been found to attack *Psalloita campetsris*. The suggestions regarding the addition of carbohydrate material along with nitrogen source in the bed, cultivating other varieties of better flavour and improvement of flavour through nutrients were noted and would be investigated in detail. Work on improving the yield of subsequent crops, expressing the yield on dry weight basis and use of cellulose decomposing organism would also be undertaken.

The President, in his concluding remarks, said that the work reported, should be considered as a good beginning in the field and indicated that more work should be directed towards yield and cost data based on large-scale trials. He stressed that it was desirable to study the effect of aeration of the spawn medium. He was of the opinion whether factors responsible for natural growth of mushroom around termite area could not be taken advantage of. He suggested that intensive work should be undertaken to preserve mushrooms in a fresh state to facilitate marketing.

Information and Advice

IN pursuance of the policy of rendering technical aid to food industries in the country, the CFTRI supplies information on technical and other problems, carries out analytical work and undertakes short- and long-term investigations on behalf of the industry, besides bringing out publications containing important technical advances in different aspects of Food Science and Technology. The Institute deals with a number of enquiries from various food industries and others interested in Indian processed food products. A few of the enquiries answered are reproduced in this section.

Chemical compositions of tea brew and coffee decoction

E (*IS*) 13

Tea brew 170 ml.

Total solids ...	0.42—0.58 g.
Caffeine	0.04—0.05 g.
Tannins	0.09—0.16 g.
Crude proteins ...	0.04—0.05 g.
Minerals	0.05—0.07 g.
Total sugars ...	0.08—0.16 g.

Coffee decoction 170 ml.

Total solids ...	1.87 g.
Caffeine	0.10 g.
Chlorogenic acid (tannin-like constituent)	0.32 g.
Crude proteins ...	0.34 g.
Minerals	0.28 g.
Sugars	0.17 g.
Complex sugars (polysaccharides)...	0.43 g.
Organic acids (citric, malic, caffeic, tartaric, acetic, pyruvic and oxalic) ...	0.14 g.

Bergamot oil

E (*IS*) 14

Bergamot oil is obtained from the fresh peels of bergamot oranges (*Citrus aurantium*) by expression. Commercial oil is greenish brown in colour with a pleasant odour. This oil is used to a large extent in the manufacture of *eau de cologne* and *lavender* water. It is also used for scenting toilet soaps and in mixed perfumes. Oil has powerful germicidal value comparable to that of phenol and is especially effective in destroying flies. India is importing this oil to meet her requirements.

Different types of milks

E (*IS*) 15

Toned milk is a blend of the fresh liquid milk with suitable quantities of reconstituted milk from skim milk powder in order to achieve the desired specifications in respect of its fat content, total solids and solids-not-fat.

Skim milk is the residual part of fresh milk from which cream (fat portion of the milk) has been removed by suitable mechanical device and it finds use in preparations where fat is not desirable.

Condensed milk is concentrated fresh milk (3-4 times) from which the water portion has been removed by specialised techniques such as vacuum concentration. This can be reconstituted to ordinary milk by addition of water in suitable quantities.

As the nutritional values of the three milks referred to above are obvious, both the skim milk and the toned milk are good for sick people while condensed milk may be a better choice for use in tea and coffee.

Milk powder being cheaper than liquid milk, the cost of toned milk works out to be cheaper than the ordinary milk.

Tomato sauce

E (*IS*) 16

For the preparation of tomato sauce, good quality, fully ripe, deep red tomatoes should be used in order to get a product of excellent quality and colour. If under-ripe tomatoes are used for tomato sauce preparation, permitted colour (tomato red) is to be added to make the product appear attractive.

The pattern of costing is given on the assumption that 100 lb. of tomatoes would yield about 60-65 lb. of the pulp having a total soluble solids of 7-8 per cent resulting in the production of 3 dozen bottles (12 oz.) of tomato sauce.

Tomatoes—100 lbs. @ Re. 0.10 nP per lb.	10–00
Spices (as per recipe supplied to you)	2–00
Salt and sugar (as per recipe supplied)	1–50
Glacial acetic acid	1–00
Bottles and crown corks (3 dozen each)	10–00
Labour charges (2 labourers @ Re. 1.25 per day) ...	2–50
Other overheads include cost of fuel, water, packing, maintenance, depreciation on equipment and miscellaneous	2–50
Production cost of 3 dozen 12 oz. tomato sauce ...	29–50

The cost of tomato sauce available in the market varies from 90 nP to Re 1.20 nP per bottle of 12 oz.

A unit with a daily production of 12 dozen of 12 oz. tomato sauce bottles can be considered as an economical one.

Tomato sauce prepared for marketing purposes should conform to the FPO specifications, which are given below:

Total soluble soilds—not less than 25 per cent.

Acidity as acetic acid—not less than 1.2 per cent.

Pan-puri

E (*IS*) 17

Pan-puri is a chutney prepared from tamarind extract with added sugar, spices, salt and some fruits like raisins, etc. Because of the thinness and lesser quantity of the acid, the chutney ferments after a day or so, but it can be kept for longer period by increasing both the acidity (the tamarind extract) and sugar and salt added. Thus, a thicker chutney would keep longer as well as taste better. Exact proportions will have to be worked out by trial and error.

Potato products

E (*IS*) 18

Edward variety of potatoes have proved successful as the best variety for the manufacture of chips. The percentage yield of dehydrated potato chips will be about 12-15 per cent of the fresh weight. Dehydrated and fried potato chips can be packed and preserved in polyethylene bags, waxed glassine, cellophane and aluminium foil. Potato chips can be used for the manufacture of potato starch in commerce. Potato peelers (electrically operated), slicer (both hand and power operated) and mechanical driers are used for getting products better in quality than the ordinary sun-dried products.

Saccharin

E (*IS*) 19

Saccharin is the sweetening material used in the aerated water industry. The quantity of saccharin required per bottle of 10-12 oz. is ½ grain. Aerated waters can be preserved for about a week provided the bottled product is stored in a cool place.

The permissibility of the use of saccharin in food products is governed by the Prevention of Food Adulteration Act 1955 and the Fruit Products Order 1955.

De-shelling of cashewnuts

E (*IS*) 20

Recent methods used in factories for roasting: Oil bath processes, aiming at quick and uniform roasting and higher recovery of cashew shell oil, have recently been adopted by the manufacturers of cashewnuts. The nuts held in wire trays, are passed through a bath of cashew shell oil kept at 370-380°F at a uniform rate. Owing to the high temperature and the presence of a little moisture (7-8 per cent), the oil bearing cells of the shell burst and the exuded oil passes into the bath, at the same time the nuts are roasted to the desired degree. The recovery of shell oil is higher and the residual oil in the broken shells is only about 10-15 per cent.

Shelling: The nuts after roasting are broken and shelled with the help of light wooden mallet. The finger tips of the worker are smeared with ash during this operation. The operation is done very carefully to get the least possible quantity of broken nuts.

Peeling: The shelled nuts are then dried in sun or in a hot air chamber. This facilitates the removal of their brown seed-coat over the kernel. The kernels with the outer skin keep for a longer time and are cheaper.

After peeling they are spread out in-doors on cement flooring to allow them to absorb some moisture so as to make them less brittle. Thereafter they are kept in well ventilated rooms for two to three hours. This is not necessary for sundried nuts.

Kesaridal (*Lathyrus Sativus*)

E (*IS*) 21

Kesaridal, just like other pulses, is a good source of proteins (containing about 28 per cent) having a low biological value. This forms the staple diet in certain regions in India during periods of famine and food scarcity. But it has been reported that the prolonged ingestion of large quantities of kesaridal in human beings produced a disease known as *Lathyrism*, the main symptoms of which are paralysis, skeletal changes, reproductive failure etc.

Cocoa flavours

E (*IS*) 22

Cocoa powder is usually preferred with an added flavour and this is invariably a simple vanillin mixture, strengths of 0.01-0.02 per cent, being sufficient. A very careful blend with small quantities of cinnamon powder (0.02-0.04 per cent) is also a useful variation in some brands with almond, tolu, etc. On the other hand, cocoa powder itself is used as a subsidiary flavouring agent, not only in biscuits, confections and table delicacies, but also in appreciable quantities in tobacco. It may be added that no preservative is added for cocoa powder.

Cocoa powder is used as a beverage. It has a stimulative effect which is due to theobromine (2.2—3.5 per cent). It is used in preparing various patent food products.

Milling of paddy

E (*IS*) 23

The milling of paddy yields the following:

Hulls	17.4—20.9	per cent
Bran	8.0—13.6	,,
Polish	1.8— 4.0	,,
Head rice ...	39.4—65.0	,,
Screenings ...	3.0— 9.3	,,

The composition of an average sample of rice is as under:

Moisture	12.5	per cent
Protein	6.6	,,
Ash	0.6	,,
Carbohydrate ...	79.6	,,
Fat	0.5	,,
Fibre	0.2	,,
Calcium (mg) ...	0.01	,,
Iron (mg)	1.8	,,
Phosphorus (mg) ...	120.0	,,
Thiamine (mg) ...	0.11	,,
Riboflavin (mg) ...	0.02	,,
Nicotinic acid (mg) ...	1.2	,,

Notes and News

STATISTICAL NOTES

All-India final estimate of groundnut, 1961-62

	1961-62 (Final estimate)	1960-61 (Partially revised estimate)
Area (thousand acres)	15,848	15,461
Production (thousand tons of nuts in shell)	4,682	4,391
In metric units		
Area (thousand hectares) ...	6,413	6,257
Production (thousand metric tons of nuts in shell)	4,757	4,462

(*Economic and Statistical Adviser, Ministry of Food and Agriculture, Government of India*)

Annual world yeast production and consumption
(approximate figures)

Country	Population (millions)	Yeast production* (million lb.)	*Per capita* consumption	
			Yeast lb.	Flour lb.
Australia	10	15	1.5	300
Austria	7	14	2.0	190
Brazil	65	35	0.54	...
Canada	15.5	30	1.94	190
Colombia	14	10	0.71	...
Finland	4.4	18.5	3.98	251
Iran	20	...	...	300
Japan	91.5	36	0.4	...
Mexico	33	10	0.3	80
New Zealand	2.3	5	2.17	300
United Kingdom	52	110	2.1	175
United States	175	300	1.72	167

* Calculated as compressed yeast, 70% moisture.
(*Cereal Sci. Today, December* 1961, p. 321).

NEWS BRIEFS

New protein-rich foods in Africa: According to F.A.O., Rome, the use of certain protein-rich foods, such as presscakes of groundnuts and fish flour, is being investigated in Morocco, the Congo, Nigeria, Senegal and Uganda, the Republic of Togo, Angola and the Cameroons.

A fish flour plant, built by private industry with assistance from F.A.O. in Morocco, produces a ton of flour a day for use in child feeding programmes. Non-traditional fish products are being produced and tried in Tunisia, aiming at replacing imported skim milk in the feeding programmes. A groundnut flour factory that can produce 10 tons a day of a highly nutritive product has had its produce approved for sale and development in West Africa by an international committee. Recently, an F.A.O. expert prepared plans for a biscuit factory in Uganda, the flour being made of local maize and groundnuts.

National nutrition committees already established in South Africa, Northern, Western and Eastern Nigeria, Angola, Cape Verde Islands, Senegal and Sudan, Ghana and the Cameroons, can make a valuable contribution to the solving of nutrition problems in Africa.

F.A.O. and the World Health Organization (W.H.O.) have organized courses to train personnel in nutrition. So far, some training has been given to about 100 workers in countries and territories in Africa, south of the Sahara. The trainees have reinforced existing services in the Congo, Togo, Senegal and Sudan and Uganda, and have helped to create new nutrition services in the Ivory Coast, Ghana, Cameroons, Madagascar, Republic of Congo and the Portuguese territories (*Food Technol. Austr.*, January 1962, p. 43).

Heat penetration into plastic packages for heat-processed foods: Investigations of Wornick, Karel and Proctor of the Food Technology Department of the Massachusetts Institute of Technology have shown that the rate of heat penetration into a container (into which a product is packaged before heat processing) influences, to a large extent, the heat processing times required to provide sufficient sterilization for the product. With the use of plastics for packages increasing daily, the authors investigated the rates at which heat is conducted into containers made of flexible plastic films. Describing the details of the experimental work, they show heating curves of the various materials tested, and conclude that the films tested are interchangeable as packaging materials without altering heat-processing time very much, and offer little resistance to heat conductivity into the package (*Food Technol. Austr.*, January 1962, p. 47).

Protein-rich food problems in developing countries: *Kwashiorkor*, with its debilitating effects in infants and children, has been characterized only recently as a protein deficiency problem, occurring primarily in tropical and economically underdeveloped areas, where a complex of social, economic, sanitary and other environmental factors appear to influence the incidence and severity of the disease. The limited possibilities for increasing the supply of milk and other animal proteins in the diets of these areas have led the U.N. agencies into a programme of active exploration of alternative low-cost protein foods for infants and children, derived from local resources not previously used maximally for human food.

A six-year human nutrition study of suitable protein supplements derived from cottonseed, peanut, soy, sesame and sunflower seed, coconut and fish is now leading to an expanding programme of production and use of these supplements. Emphasis in the programme on maintenance of maximum biological value of the protein in such foods requires quality and processing standards that are in some cases difficult to meet by conventional production technology.

Problems now receiving attention include processing losses of essential amino acids by cooking and drying, elimination of toxic factors, preparation of foods of optimum physical form, sanitary quality, stability, and palatability, and last but not least, the overcoming of popular resistance to new or unfamiliar foods (*Food Technol. Austr.*, February 1962, p. 85).

Leaf protein milk plant in Jamaica: A machine for extraction of protein from the leaves of tropical plants is being constructed in Jamaica, West Indies. It is the result of more than 20 years of research on leaf protein extraction, primarily by Dr A.J. Pirie, Rothamstead Research Institute, U.K.

The extracted protein is to be used as an additive in both human food and animal feeds. The plant is being erected by the University College of the West Indies under supervision of the Scientific Research Council of Jamaica.

The unit is designed to be mobile so as to take maximum advantage of the varying tropical vegetation of the 4,400-square mile island. It will produce 20-80 lb. of protein from one ton of leaves or grass in an hour. (*Food Technol. Austr.*, February 1962, p. 85).

A new preservative for fruit juices: Diethyl pyrocarbonate, a colourless liquid with a fruity odour may prove useful in the fruit juice industry as an inhibitor of unwanted fermentation and bacterial spoilage.

Russian scientists, in 1951, found that diethyl pyrocarbonate occurs naturally in champagne and may be concerned in the formation of champagne qualities. Research workers in Germany and U.S.A. found that diethyl pyrocarbonate is an effective inhibitor of residual-sugar fermentation in wine. Concentrations of 100 ppm controlled yeast activity, and were not detectable by taste.

The suitability of diethyl pyrocarbonate for preservation of fresh grape juice has been examined by Swiss scientific workers. They found that the quantity used depended on the kind of organism present, ranging from 0.05 to 0.1 per cent. Hydrolysis of the pyrocarbonate was complete within 24 hours, carbon dioxide and ethyl alcohol being formed (*Food Technol. Austr.*, February 1962, p. 88).

Pre-peeled potatoes: The potatoes for pre-peeling are first stored for three days at 72-75°F to allow sugar build-up, then placed for two minutes in an agitated solution of caustic soda held at 175° F. From here they are put into a tumbler with jet water sprays to remove the peel from where they go to a treating tank where all traces of alkali are removed. Any eyes and blemishes are then removed by hand.

Potatoes intended for chips are sliced and treated with sodium bisulphite and the whole and sliced potatoes are packed in 30lb bags, made of polythene-lined kraft. The bagged potatoes are stored under refrigeration (*Food Technol. Austr.*, February 1962, p. 88).

Detection and quantification of aromas: In the course of tests based on the variation of the electric conductivity of liquids containing dissolved gases or vapours, it has been found possible to design special galvanic cells where one of the electrodes, generally a sieve, is in simultaneous contact with the electrolyte and with the analysed atmosphere whilst the other electrode is completely immersed. Due to electrochemical or even electrophysical action, the gaseous flow directed on the sieve which, with its bottom surface, is in contact with the electrolyte, produces a variation of the galvanic current between the two electrodes so that it can serve as a highly sensitive detector of minute quantities of gases or vapour. For instance, a platinum sieve in contact with distilled water, in conjunction with another electrode which may consist of platinum or lead, can be used for the detection of very small quantities of acids and bases, and this technique can be applied to the detection and quantification of many food aromas, after extraction and isolation by means of gaseous chromatography. The galvanic cells thus acting as 'artificial noses' have been named 'Osmopiles,' (*Food Manuf.*, December 1961, p. 535).

Chemical changes in frozen fish: The effect of frozen storage and glazes on some chemical changes in fish was studied. Moisture content decreased on storage whereas total protein nitrogen apparently increased. Total amino-nitrogen decreased. The loss in total amino acids and change in PDR index of fish was observed during frozen storage. The changes mentioned above were slowed by glazes. The ratio of Ba-acetate non-precipitable ribose to total ribose increased during storage. The possible route of formation of Ba-acetate non-precipitable ribose has been suggested (*Food Manuf.*, December 1961, p. 536).

Lead in food regulations: Regulations made by the Minister of Agriculture, Fisheries and Food jointly with the Minister of Health lay down statutory limits for the lead content of food and beverages imported, sold or intended for sale for human consumption.

They limit to 0.2 p.p.m. the lead content of ready-to-drink non-alcoholic beverages, limit to 2.0 p.p.m. the lead content of other foods, and allow, for certain specified beverages and foods, different limits which in certain instances apply only for a limited period.

They do not apply in the case of fish (including crustacea and molluses) or any product containing such fish for which a natural lead content in excess of 2.0 p.p.m. has been established, nor where certain food contains lead in proportions exceeding 2.0 p.p.m. by reason of the inclusion, as an ingredient or ingredients, of a substantial quantity (defined as not less than 25 per cent by weight of the composite article of food) of a food or foods specified in the schedule to the regulations; and where such excess of lead does not exceed the maximum quantity, proportionate to its weight, permitted for the added specified food or foods.

The regulations provide that where any food is certified by a public analyst as being food which it is an offence against regulation 3 to sell, consign or deliver, or import into England or Wales, that food may be treated for the purpose of section 9 of the Food and Drugs Act, 1955 (under which food may be seized and destroyed on the order of a Justice of the Peace), as being unfit for human consumption (*Food Manuf.*, December 1961, p. 537).

New vinegar containers: An alternative method of packaging vinegar, replacing the heavy bulky barrel with its attendant sterilisation and co-operate problems, is now in use. Caselloid have manufactured a strong welded p.v.c. container, capable of holding four gallons of vinegar. This container is protected in a strongly stapled stout, non-returnable carton, which reveals a leak-proof tap when the lid is removed. The container does not impart taste or odour, it is claimed.

Reed have also produced a non-returnable vinegar container for the C.W.S. It incorporates a blow-moulded, low-density drum in a corrugated fibreboard carrier and transit outer, combining light weight and ease of handling with a high degree of impact and tensile strength.

The drum has been designed with a flat top to contain exactly five gallons. The tap admits no air therefore when the level of vinegar drops the walls of the container collapse (*Food Manuf.*, February 1962, p. 79).

Advances in hydrostatic sterilisation: Hydrostatic sterilisation is likely to be used increasingly in modern canning plants. The latest equipment produced for this purpose by the Dutch firm, Stork and Co., Amsterdam, is designed for the continuous handling of both circular and rectangular cans; these are subjected to carefully controlled temperature changes and are released in dry condition so that losses are claimed to be lower than with any other system. Moreover, because of the strict automatic control, the heat treatment is uniform, and therefore ensures uniformly high quality of output. In comparison with autoclaves, the hydrostatic sterilisation plant is claimed to be considerably cheaper in operation, due to drastic savings in labour, floor space, steam consumption and water consumption (*Food Manuf.*, February 1962, p. 84).

Freeze-drying commercial requirements: Freeze-drying is the latest development in the sphere of food preservation. Whilst this process used to be mainly confined to applications in the pharmaceutical industries, where it was easier to absorb its relatively high costs, it has lately become possible to reduce both the first cost and the production cost of the process to such an extent that freeze-drying has become an economic proposition for the treatment of a number of foods on an industrial scale. The author discusses the conditions which must be observed if the process is to yield high-quality products with the aid of the special equipment and packaging methods available (*Food Manuf.*, February 1962, p. 85).

Success with fruit juices: Handling of record quantities of oranges had been attributable to a greatly increased outlet for carbonated drinks, the canning of pure orange juice for the home market, and the packing of orange juice cordials. Much progress had been made in the output of these drinks, composite packs in 15-oz. cans—pineapple and orange juices and pineapple and grapefruit juices—having met with much marketing success.

The report stated that owing to the restricted production of pineapples shipments to Canada had to be curtailed, but an encouraging aspect of the export trade had been the favourable reception of the pack of tropical fruit salad in America, to which country a substantial portion of the 1961/62 pack would be sent (*Austr. Food Manuf.*, December 1961, p. 74).

Pineapples: Following two unfavourable marketing experiences for Queensland pineapple growers, they expect a substantial price improvement for this season's crop. In 1959 and 1960, exceptionally heavy production resulted in as little as £15 a ton being returned for first-grade fruit. This year, it is anticipated that it will yield an average of about £40 a ton. The smaller plantings influenced by the earlier low prices, combined with a severe winter, however, have resulted in much lower production, and the effect will be to reduce Queensland's export earnings for canned pineapples, which were £3 million in 1959, to £750,000 this year. When canning finishes at the end of November, it is expected that the total intake of the canneries will be 39,000 tons compared with 67,000 tons in 1959, and 61,000 tons last year. It is understood that somewhat similar conditions exist in South Africa and Malaya. Prospects for next year's Queensland crop will depend to a great extent on the decision of growers as to whether, in view of the improvement in prices, increased production is justified. An interesting innovation in the inspection of the pineapple plantations between Brisbane and Maryborough, on the north coast, was made recently by the manager of the C.O.D. cannery at Northgate, Mr J. F. S. Brown, who in 8½ hours flew over 300 miles in a helicopter, the flight enabling him to gain an impression of the condition of the plantations and the extent of new plantings. The seasonal outlook for the industry so far is promising, good rains having fallen over most parts of the area in which fruit is grown (*Austr. Food Manuf.*, December 1961, p. 76).

Quicker cooking of dried green peas: Dehydrated green peas require a long soak in water before they can be cooked. This is a disadvantage to the consumer, and experiments aimed at reducing the preparation time have been carried out by the Division. Chemical treatment of the skin did not result in increased rate of reconstitution, but mechanical slitting of the skin gave shorter soaking and cooking times. Current tests are aimed at producing a material closer to the instant-type product. This involves the drying of fully precooked peas which have been passed through a slitter (*Austr. Food Manuf.*, February 1962, p. 34).

Sulphuring dried tree fruits: Sulphur dioxide is used to protect the natural colour and flavour of apricots, peaches and pears during drying, storage, and distribution to the consumer. Since Australia and importing countries, by regulation, impose maximum limits for this preservative in dried tree fruits, it is essential that processors should have adequate control over its application and retention by the fruit during drying.

During the last five years, factors affecting the rate of absorption of sulphur dioxide by fruit, and losses occurring during the drying process, have been investigated. The application of these results on a pilot scale is proceeding, and appropriate recommendations on sulphuring methods will be made to the industry in due course (*Austr. Food Manuf.*, February 1962, p. 34).

Liquid invert sugar: More sweetening per gallon is provided by liquid invert than by liquid sucrose, according to this company. The product also resists staling, and is said to be a 'doctoring agent' because it prevents crystallization. These characteristics extend the shelf-life and improve the quality of products containing sugar. No extra charge is made for the sugar inversion. Industries likely to use this product include those making beverages, syrups, preserves, and bakery products (*Canad. Food Industr.*, February 1962, p. 63).

FDA whole fish flour proposal: The 'whole fish flour' would be made from grinding various-sized whole fish, removing the fat by chemical process, and drying the flour.

The proposed FDA standard includes these specifications:

1. Protein content, measured by methods of the Association of Official Agricultural Chemists, shall not be less than 70 per cent by weight of the final product and biological values of the final fish protein concentrate.
2. Moisture and ash contents shall not exceed 6 per cent and 25 per cent by weight of the final product.
3. Fat content shall not exceed one per cent.
4. The final product should have no more than a faint fish odour and taste, and when baked in bread in the ratio of one part of fish protein concentrate to 11 parts of grain flour there should be no detectable fish odour or taste.
5. The fish protein concentrate, after six months of storage at temperatures prevailing in areas of intended use, but not exceeding 100 degrees F, packed in metal containers or in polyethylene bags, should show no spoilage as judged by the development of off flavours, mold growth, production of toxic amines, or by deterioration in protein quality as shown by digestibility and available lysine values below the specific minima (*Food Technol.*, December 1961, p. 37).

Liquid nitrogen as food-freezing agent: Using liquid nitrogen as the freezing agent, a 49-thousand-pound shipment of fish, recently loaded into a railroad car at Vancouver, B.C., by British Columbia Packers Ltd. at 39°F below zero, arrived in Montreal six days later at an average temperature between 50 and 60 degrees below zero.

The liquid-nitrogen process has been granted 100 per cent insurance coverage by Lloyds. Coverage for frozen foods generally averages only about 60 per cent.

Foods can be brought down to below 0°F in less than five minutes with liquid nitrogen. The food is placed in an insulated container, truck trailer, or railway car. The nitrogen is then sprayed into the top of the container.

A spring-loaded insulation system has been designed for uninsulated railway cars and highway trucks. In addition, a line of standard-size insulated containers is available that can be transported by rail, truck, or steamship, above or below decks, without modification of the transportation medium (*Food Technol.*, January, 1962, p. 26).

Nescreme: Dairy product for use in both fresh brew and instant vending coffees, is the new name for Nestle's improved powdered formula. The product is packed in specially laminated aluminium foil bags with the convenient pour-easy service feature. Company officials say the new dairy formula, available since July, actually reduces creaming costs by as much as 20 per cent. Other Nescreme features include longer product life in canisters, no distortion of coffee flavour, and rapid solubility. More details are available from the Nestle Company, Inc., Vending and Institutional Marketing Division, White

Plains, N.Y. (*Coffee and Tea Industries and the Flavour Field*, December 1961, p. 47).

Automatic titrator: A titrator featuring complete automation is described in a 4-page bulletin, as follows: It automates the typical titrimetric procedure — transfers aliquots of sample, adds diluent or reagent, titrates to present end points, and prints the result opposite the corresponding sample number in terms of titrant used to reach the end point. Its capabilities are said to include performance of either direct or back titrations for acid-base, oxidation-reduction, or conductimetric systems. Further, the manufacturer mentions that it can be modified to maintain constant pH levels; automatic draining and washing of titration vessels permits the apparatus to operate continuously for any length of sample series, releasing the technician from attendance, eliminating the labour of washing glassware, and reducing breakage (*Cereal Sci. Today*, February 1962, p. 50).

New enzyme formulation boosts tenderizing action: Meat tenderization may be improved with use of new enzyme formulations containing papain and pyrophosphates as carriers.

Cuts treated with proteolytic enzyme alone have many shortcomings. The most serious problem is that the enzyme continues to act on the meat surface and makes it mushy unless the action is stopped promptly by freezing or cooking.

When enzymes are applied by dipping, the action is primarily a surface phenomenon. Deep tissue remains unattacked, while the surface becomes soft and mushy. Furthermore, in the live-injection method, edible glands and organs are also tenderized and are less desirable.

However a carrier, such as a pyrophosphate, can be used to convey the enzyme through osmosis into the deep tissues. The action can be so controlled that a lower concentration of enzyme can be used, while efficient tenderization is achieved by the more uniform distribution of enzyme.

Thus, when meat is dipped in a phosphate solution containing a small amount of active enzyme, it can be held for upto 5 days at 32-38° F without any apparent softening of tissues.

A formulation that proved particularly effective in tests conducted at Michigan State University contains 0.6 g. of papain and $17\frac{1}{2}$ oz. of pyrophosphates per gallon (*Food Engng.*, December 1961, p. 102).

INDIAN PATENTS

71900. *Improvements in or relating to apparatus for the comminution of whole citrus fruit:* Apparatus comprising a hopper, a plurality of citrus fruit comminuting devices for discharging into the hopper, agitating means and feed means for feeding fruit from said hopper—J. Lyons & Company Limited (*Gazette of India*, Part III—Sec. 2, p. 370).

71901. *Improvements in and relating to the manufacture of beverages and the like:* Comminuting whole fruit by means to rupture fruit sacs and oil cells, separating liquids from solids by gradually increasing pressure and adding sugar syrup to the said liquid—J. Lyons & Company Limited (*Gazette of India*, Part III—Sec. 2, p. 370).

70439. *Preparation of white pepper from black pepper by chemical process:* Comprising first soaking black pepper in pure water for swelling then treating with alkalies, alkaline earth salts or alkaline salts and heating to boiling till the skin becomes soft and can be removed by rubbing or mechanical means then bleaching the product and then drying—D. G. Joshi (*Gazette of India*, Part III—Sec. 2, p. 385).

72167. *Purification of sugar solutions:* Passing hot sugar solution upwardly through an elongated vertical column counter-current to downwardly flowing bed of decolorising adosrbent, maintaining a body of purified sugar solution above the bed, supplying adsorbent through the body of purified sugar solution, withdrawing spent adsorbent and withdrawing purified sugar solution —The American Sugar Refining Company (*Gazette of India*, Part III —Sec. 2, p. 387).

71063. *Production of bacterial protease by submerged culture:* Cultivating high protease producing strains of *B. Subtilis* and *B. Mesentericus* by submerged culture with vigorous stirring in nutrient aq. media—Council of Scientific and Industrial Research (*Gazette of India*, Part III—Sec. 2, p. 398).

73380. *Method for purifying fat:* Contacting the fat with concentrated phosphoric acid at 60-90° C to 0.025-0.3 per cent by volume for 5 to 30 minutes in vacuum and separating the precipitates—Aktiebolaget Pellerins Margarinfabrik (*Gazette of India*, Part III—Sec. 2, p. 400).

73382. *Process and plant for refining fats:* Comprises passing a flow of the fat in fluid state to the lower end of a vertical column on alkali lye and refining the fat by bubbling it up through the lye column — Aktiebolaget Pellerins Margarinfabrik (*Gazette of India*, Part III—Sec. 2, p. 400).

72246. *Process for the treatment of contaminated waste waters:* Waste water is introduced into the circulating water at a point upstream of the point of introduction of the circulating water to the cooling means and downstream of the heat exchanger—Sun Oil Company (*Gazette of India*, Part III—Sec. 2, p. 400).

72253. *A device for sampling sugar juices:* Comprising an electronic circuit a timing and a sampling unit said circuit consisting of a transformer and rectifier with one or more secondary circuits provided with micro switches, relays and lamps—R. C. Sharma (*Gazette of India*, Part III—Sec. 2, p. 409).

74370. *Improvements in or relating to pulverising mills:* A separate blower fan is provided to supply pressurised air and means to feed material to be comminuted to the fan so that the fan serves to accelerate the particulated material into the mill with air—Russell

Constructions Limited (*Gazette of India*, Part III—Sec. 2, p. 7).

72954. *Process for separately recovering edible mustard seed meal and either sinigrin or allyl isothiocyanate:* Crushing the mustard seed, separating the oil from the curshed seed, extracting the resulting seed with hot water, separating the liquid and solid phases, drying the solids and separating sinigrin from the liquid—Oil Seed Products, Inc. (*Gazette of India*, Part III—Sec. 2, p. 12).

74292. *Improvements in or relating to components for containers:* A thin sealing element secured to the component by a thermo-setting polymer paste to form a seal to the hole in the component—The Metal Box Company Limited (*Gazette of India*, Part III—Sec. 2, p. 13).

72778. *Process for preparing food-stuffs of improved taste and increased nutritional value:* An oil or fat containing foodstuff which also contain l-lysine-l-glutaminate —Stamicarbo N.V. (*Gazette of India*, Part III—Sec. 2, p. 28).

FOREIGN PATENTS

847,677. *Food products:* A food substance which on immersion in hot edible oil or hot air affords a puffed product is prepared by mixing starch with water, milk or other aq. fluid to form a viscous paste, then heating the latter to gelatinise the starch, admixing the resulting paste with starch or a mixture of starch and flour, heating the resulting dough (to effect gelatinisation thereof), drying slabs or blocks of the dough at 140°F, and cutting the dried product into thin flakes—H. S. Whiteside & Co. Ltd., (*J. Sci. Food Agric.*, December 1961, p. ii-275).

850,552. *Levan sucrase:* To obtain solutions of levan sucrase of relatively high concentration and in good yield from a levan-forming strain of *Bacillus subtilis,* there is added to the culture, besides the complex org. nutrient ingredients (I) of the culture, ammonium sulphate in concentration 0.03-0.2 per cent (or an equivalent amount of another NH_4 salt), sucrose in concentration 2-15 per cent and phosphates in concentration 0.005-0.5 per cent, and the culture is then subjected to fermentation with intense aeration (such that the nutrient medium absorbs an equal vol. of air per min. while stirred at 300-700 r.p.m.) at pH 6-7 and at 30°C. for 7-15 h. The pH must be kept at 6-7 throughout the fermentation, by additions of $CaCO_3$ or Na_2CO_3, etc.; and I must be free, or first be freed from org. and inorg. substances that are precipitable by heat.

I are preferably provided by a 2 per cent solution of corn steep liquor that has been heated to 100-120° at pH 7, and thereafter filtered; and this filtrate may serve as the culture medium, and as the nutrient medium for the fermentation after adding the sucrose and ammonium salt—Farbenfabriken Bayer A.-G. (*J. Sci. Food Agric.*, January 1962, p. i-34).

847,935. *Utilization of mycelium waste from the production of citric acid in the conversion of starch in amylaceous raw material to fermentable carbohydrates:* Mycelium waste from the production of citric acid with the aid of an *Aspergillus*, *e.g.*, *A. niger*, is wasted, mechanically dewatered, heated at 50° (*e.g.* for 10-40 h.) until the cells are partly autolysed, then dried at 65°, and ground, to give a product suitable for use in the conversion of starch in amylaceous raw material (potatoes) to fermentable carbohydrates (due to the maltase content of the product). The amylaceous material, after cooking, is preferably initially liquefied by treatment with, *e.g.*, malt, prior to addition of the treated mycelium (at 65-70). Stillage obtained by alcoholic fermentation and distillation of a mash thus converted is suitable for use as fodder for animals—M. Burger, K. Beran and Z. Fencl (*J. Sci. Food Agric.*, January 1962, p. i-34).

849,948. *Fermented meat products:* A meat product, especially sausage, is fermented (and the flavour thereby improved) by treatment with a fermentative culture, *e.g.*, *Pediococcus cerevisiae*, in presence of $Mn^{\cdot}$ (0.5-4 per cent on the culture, and 3 mg. per 100 lb. of meat product). Merck & Co. Inc. (*J. Sci. Food Agric.*, January 1962, p. i-49).

849,787. *Vitamin A compositions:* A vitamin A ester (acetate or palmitate) is dispersed in a reaction product of CH_2O and partly hydrolysed casein (containing 0.5-7 wt.-per cent of α amino N). preferably in presence of an antioxidant, *e.g.* a mixture of butylated hydroxyanisole and butylated hydroxytoluene, to provide a highly stable vitamin prep., suitable for incorporation into animal feeds or feed supplements and in pharmaceutical compositions—Merck & Co. Inc. (*J. Sci. Food Agric.*, January 1962, p. i-53).

853,636. *Fungicidal compositions containing isocycloheximide:* There is claimed a horticultural fungicidal composition comprising isocycloheximide (I) and a diluent or carrier (water and/or water-miscible solvent or wettable powder). The composition is especially effective in the control of cherry leaf spot and is translocated so that new foliage growth as well as treated foliage is protected. I, m.p. 101-102°, $\alpha^{23}_{D} \pm 26°$ to $\pm 36°$, is recovered from mother liquor from the recrystallisation of cycloheximide and is an isomer of the latter—Upjohn Co. (*J. Sci. Food Agric.*, February 1962, p. i-80).

853,773. *Starch manufacture process:* In the recovery of starch from starch-bearing material (roots and stems) by processing in a wet system to release starch from the cells and to produce a starch slurry, a product of improved quality is obtained by feeding the wet starch-bearing material into a high-speed rotating rotor disc (peripheral speed $<$21,000 ft. per min.) which imparts its velocity to the material and impinges it upon a surface such that the granules of starch are released from the cells without shredding them or the vascular fibres—Corn Products Co. (*J. Sci. Food Agric.*, February 1962, p. i-92).

853,928. *Dustless starch:* A dustless, partly or completely gelatinised starch, suitable for use, *e.g.*, in the brewing industry and in paper making, is obtained by conveying moist starch (of <25 per cent water content) in a current of air through a flash dryer supplied with air having at the starch inlet a wet-bulb temp. of between 170°F and 212°F and a dry-bulb temp. within the range of the wet-bulb temp. and the temp. at which the starch decomposes, preferably <318°F. then separating the gelatinised starch in dry form.—Corn Products Refining Co. (*J. Sci. Food Agric.*, February 1962, p. i-92).

853,046. *Preservation of vegetable products:* Natural flavour and texture of a vegetable product (peaches, bananas, strawberries, citrus fruits, fruit juices and also enzymes obtained therefrom) are preserved by treating (in liquid medium) at <25° with a food preservative (*e.g.*, sorbic acid, Na or K sorbate; 0.025—0.1 wt. per cent) then heating for 5-50 min. at 37—55°, preventing access of air, then cooling to <25°—E. A. Weaver (*J. Sci. Food Agric.*, February 1962, p. i-96).

852,053. *Uniformly palatable soya-bean protein concentrate:* Divided natural or defatted soya-bean material containing water-sol. ingredients is extracted mechanically with water at about the isoelectric point of the protein content of the material. Undissolved solid is then separated off, and washed free from beany-tasting ingredients with water to give a uniformly palatable product suitable for use as a food additive (especially to meat, *e.g.*, in an encased product like sausage). If desired, the solid product may be converted into a Na proteinate by treatment with aq. alkali at pH 6—10.5 and 38.7-82°—Griffith Laboratories Inc. (*J. Sci. Food Agric.*, February 1962, p. i-96).

852,559. *Artificial chocolate flavour base for confectionery products:* An artificial chocolate flavour base for confectionery products comprises a substance obtained by heating a reducing saccharide (*e.g.*, glucose, galactose, mannose, laevulose, sorbose, lactose, maltose or manninortriose) 90-170° with a protein hydrolysed to 8—70 per cent. The protein may be vegetable protein (derived, *e.g.*, from wheat, maize, hemp, soya-bean, rye, oats, groundnut, or barley) or animal protein (derived, *e.g.*, from milk protein, egg albumin, serum albumin, fish albumin, gelatin, elastin, collagen, or keratin)—General Food Corp. (*J. Sci. Food Agric.*, February 1962, p. i-97).

953,255. *Meat:* Surface shrinkage of meat is inhibited (and shrinkage during subsequent storage thereby prevented) by coating the surface with an aq. dispersion of an alkanol of 11-22 C or a fatty acid of 12-23 C (or its Et ester), *e.g.*, hexadecanol, octadecanol or arachidic acid. The dispersion may contain an emulsifying agent (*e.g.*, a propylene glycol or glycerol partial ester of fatty acids of 10-20 C and is applied to fresh un-frozen meat—T. R. Anderson (*J. Sci. Food Agric.*, February 1962, p. i-104).

877,521 & 522. *Coffee extract:* Relate to an improved method of producing coffee extract in the form of a syrup or dry soluble powder of a high concentration with desirable flavour taste and aroma, by acqueous counter-current extraction of roasted coffee in zones of different temperatures—General Foods Corp. (*Food Trade Rev.*, December 1961, p. 101).

830,394. *Fish dressing machines:* Relates to a method of gutting fish in which while the fish is travelling belly downwards, a cut is made through the belly to sever the membrane that spans the lug bone, this cut passing between the two liver attachments—the belly is cut throughout its length, the guts are struck to dislodge them so that they fall downwards under gravity, a cut is made through the liver attachments and the gut at the throat, and finally a cut is made through the end of the colon at the vent—Fisadco, Ltd. (*Food Trade Rev.*, December 1961, p. 101).

880,687. *Preserving foodstuffs:* A process of preserving fresh meat, including poultry and fish, comprises contacting the meat or fish with a tetracycline antibiotic and then irradiating it with gamma or beta rediation—Chas. Pfizer & Co. Inc. (*Food Trade Rev.*, December 1961, p. 101).

879,325. *Fruit beverages:* Relates to a fruit flavoured beverage preparation adapted to be prepared and marketed in a dry powdered form, and which is capable of being reconstituted by the addition of cold water with gentle stirring to produce a fruit flavoured beverage closely resembling the opacity, appearance, mouth feel and palatability of natural fruit juices—General Foods Corp. (*Food Trade Rev.*, December 1961, p. 101).

879,408. *Baking powder:* The object is to provide a baking powder having a filler which permits an economical reduction in the bulk density of the powder—does not introduce a stability problem and permits a reduction in the level of active ingredients required to develop a given volume of leavening gas per level teaspoon of powder: it has been found that a water insoluble hydrated silicate such as hydrated calcium silicate can be employed as a total or partial replacement for the fillers of the prior art, in baking powder—General Foods Corp. (*Food Trade Rev.*, December 1961, p. 101).

879,221. *Packaging:* Relates to a package for dispensing individual portions of processed cheese spread and other edible products of extrudable consistency such as jams, pastes, etc., the product being extruded by manual pressure through an orifice formed at the apex of a flat sector-shaped pack formed of aluminium foil material coated with a thermosensitive sealing composition—Swift & Co., Ltd. (*Food Trade Rev.*, December 1961, p. 101).

882,959. *Canning:* Relates to an improved apparatus for the continuous cooking and cooling of comestibles in sealed containers: one of the objects is to provide an improved hydrostatic pressure cooker that is relatively inexpensive to manufacture but capable of withstanding all pressures developed; another object is to provide a continuous processing apparatus having an improved article feed and discharge mechanism—Food Machinery & Chemical Corp. (*Food Trade Rev.*, January 1962, p. 73).

882,476. *Yeast.* Relates to a process and apparatus for the production of yeast, such as baker's yeast, food yeast or fodder yeast and more particularly to a method and means of regulating the supply of the mash-containing vat of nutritive material in solution, and of air, in dependence on the instantaneous composition of the exhaust gases from the vat-Patentaswertung Vogelbusch G.m.b.H. (*Food Trade Rev.*, January 1962, p. 73).

885,027. *Fermenting tea:* Rolled tea leaf is treated in mass bulk by injecting into the mass for a given time, air which has been previously conditioned as to temperature and humidity: the method makes it unnecessary for the fermentation process to take place in an air-conditioned room—the time is reduced and the liability of bacterial contamination is greatly reduced —Brooke Bond & Co., Ltd. (*Food Trade Rev.*, February 1962, p. 79).

884,315. *Quick-cooking rice:* A method of preparing a quick-cooking rice product comprises cooking fissured raw rice in a moisture-permeable container by submerging the container in hot water or a hot aqueous cooking liquid for a period of time and at a temperature sufficient to hydrate and gelatinise the starch of the rice —General Foods Corp. (*Food Trade Rev.*, February 1962, p. 79).

DRAFT INDIAN STANDARDS

Insecticide sprayers: Hand compression sprayers and single-barrel stirrup pumps are used for spraying insecticides for the control of pests and diseases in agriculture by public health authorities. The requirements in regard to materials included in the draft specifications for these two items are only the minimum, and the use of other materials having characteristics equivalent to or higher than those specified in these drafts is not precluded. To ensure interchangeability of certain parts, which may require to be replaced, the necessary mating dimensions have been specified but in doing so care has been taken to see that no restriction is placed on improvement in design (*ISI Bull.* Nov.-Dec. 1961, p. 311).

Pomfret canned in oil: Pomfret is usually canned in oil. In order to ensure the quality and wholesomeness of the finished product, various physical, chemical, micro-biological and hygienic requirements have been prescribed in the draft Indian Standard Specification for Pomfret Canned in Oil. The formation of this specification was undertaken at the instance of the Development Council for Food Processing Industries, Union Ministry of Commerce & Industry (*ISI Bull.*, Nov.-Dec., 1961, p. 311).

Tapioca flour: Tapioca flour is prepared by powdering dried tapioca chips in a disintegrator or any other kind of grinding mill and sieved. The sieved tapioca flour is used for textile and other industrial purposes. Tapioca flour is supplied to many textile mills in larger quantities than tapioca starch and the conversion to starch is carried out at sight just prior to being used. It is estimated that in cotton textile industry alone, about 5,500 tons of tapioca starch are being used.

The draft Indian Standard Specification for Tapioca Flour for Use in the Cotton Textile Industry prescribes requirements of tapioca flour which is a sizing material. Methods of tests for various characteristics of the tapioca flour are also given.

The Indian Standards Institution has granted during February 1962 licence for the use of (i) ISI Certification Mark IS:561-1958—Specification for BHC Dusting Powders (Revised) to Messrs. Pesticides India, Udaisagar Road, Udaipur, and (ii) ISI Certification Mark IS: 1320-1959 Specification for Baker's Yeast to The Indian Yeast Company Limited, Bhadrakali, Konnagar, West Bengal.

Information from Foreign Journals

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Food Abstracts

THIS section contains abstracts of papers on Food Science and Technology selected so as to serve the needs of food and allied industries in India and is divided into three parts. Part I comprises abstracts of papers published by the CFTRI, Mysore, reprints of which can be had from the Institute on request. Part II consists of abstracts of papers published in important Indian journals. Part III contains abstracts of important articles from foreign journals.

PART I (Cftri)

Biosynthesis of choline and its incorporation by resting cells of *Neurospora Crassa*, by Dalal, F. R., Rege, D. V. and Sreenivasan, A., *J. sci. industr. Res.*, 1961, **20 C** (9), 255.—Attempts have been made to demonstrate the synthesis of choline by respiring mycelia of *N. Crassa* (wild) from ethanolamine and various methyl precursors under varied experimental conditions. In no case a net increase in choline content has been observed. The ability of the cells to bring about the synthesis could be inferred from the presence of this metabolite in the mycellium harvested from the cholineless medium. More directly the ability to incorporate C^{14} from ($C^{14}H_3$) methionine or (3-C^{14}) serine has been demonstrated.

Mycelia of both the wild type and the cholineless strains can rapidly incorporate choline into the cells, the amount incorporated increasing with the concentration of choline in the suspension medium upto 50 μg./ml. A balance sheet reveals that during the 4 hours period of incubation much (upto 30 per cent) of the choline was lost in unaccountable ways. This is not due to oxidation, demethylation, conversion to trimethylamine or degradations leading to liberation of free ammonia.

Studies on the nutritive value of *idli* fortified with Indian multipurpose food, by Joseph, K. Narayana Rao, M., Indiramma, K., Swaminathan, M. and Subrahmanyan, V., *J. sci. industr. Res.*, 1961, **20C** (9), 269.—The nutritive value of *idli* (a steamed cake from a fermented dough of rice and black gram *dhal*) fortified with Indian multipurpose food or Bengalgram flour has been studied by growth experiments on albino rats. The results show that (1) unfortified *idli* diet promotes significantly higher growth than rice diet and (2) diet containing *idli* fortified with multipurpose food promotes significantly higher growth than those containing unfortified *idli* or *idli* fortified with Bengalgram flour. The livers of animals receiving the rice diet show parenchymal damage of a mild protein deficiency type, while the livers of animals receiving *idli* or *idli* fortified with Bengalgram and Indian multipurpose food are quite normal. The mean fat content of livers of rats receiving diets based on unfortified *idli* and *idli* fortified with Indian multipurpose food or Bengalgram was significantly less than that of livers of animals fed on the rice diet.

Specific functions of vitamin B_{12} in metabolism, by Netrawali, M. S., Pradhan, D. S. and Sreenivasan, A., *J. sci. industr. Res.*, 1961, **20A** (9), 513.—Although the chemical structure of vitamin B_{12} is known and there is general agreement about its physiological importance, its role in nutrition and biochemical mode of action still await definition. In a brief survey of its several functions, the authors discuss its role in sulphydryl metabolism, methyl group metabolism and one carbon transfers, methionine synthesis in microorganisms, synthesis of nucleic acids, protein metabolism and coenzyme functions, and cite some unpublished results.

—K.M.D.

Estimation of galacturonic acid by paper chromatography, by Kadkol, S. B. and Desikachar, H. S. R., *Curr. Sci.*, 1961, **30** (9), 337.—Galacturonic acid is difficult to estimate by Dische's colorimetric method when it is mixed with polysaccharides. The acid was first separated by paper chromatography and then estimated colorimetricaly by Dische's method. Glucuronic acid did not interfere in this estimation.

—K.M.D.

Metabolic interrelationships between vitamin B_{12} and pantothenic acid in the rat, by Aiyar, A. S. and Sreenivasan, A., *J. Nutr.*, 1961, **75** (2), 235.—The elevation in hepatic coenzyme A in the vitamin B_{12}-deficient rat was attended by decreases in total soluble sulfhydryl, glutathione and total methionine. The changes were reversed and the levels returned to almost normal values within 48 hours after administration of a single dose of vitamin B_{12}.

Supplementation of a low- methionine diet with L-cysteine hydrochloride resulted in increases in liver stores of coenzyme A, total soluble sulfhydryl, glutathione and methionine, the rise in coenzyme A level being more in the vitamin B_{12}-deficient rat than in the supplemented one.

The vitamin B_{12}-deficient animal showed greater *in vivo* synthesis of coenzyme A from intraperitoneally administered precursors, than the vitamin-supplemented animal. Prior administration of vitamin B_{12} to the deficient animal decreased the coenzyme A synthesis.

Administration of L-cysteine hydrochloride to rats deficient in both pantothenic acid and vitamin B_{12} was without appreciable effect on the liver levels of coenzyme A, total soluble sulfhydryl, glutathione and methionine. Prior administration of pantothenic acid or of vitamin B_{12} favoured increased synthesis of coenzyme A or of total soluble sulfhydryl glutathione and methionine respectively.

Organic acid metabolism in tamarind leaves, by Lewis, Y. S., Neelakantan, S. and Bhatia, D.S., *Curr. Sci.*, 1961, **30,** (10), 381.—Seasonal variations of l-malic acid in the leaf sap have been studied. Synthesis of malic acid is much less than that of tartaric acid through most of the year, and only in the cold season does it become roughly equal. This indicates that its origin may be different from that of tartaric acid. Both the acids are translocated to the growing berries and are utilized but little in the leaves, if at all. —K.M.D.

The relationship of induced catalase synthesis to ribonucleic acid metabolism in yeast, by Bhuvaneswaran, C. Sreenivasan, A. and Rege, D. V., *Enzymologia*, 1961, **23,** 15-VIII, 185.—Evidence gathered with respect to elaboration of catalase in yeast on aeration points to *de novo* enzyme synthesis rather than an activation of preexisting zymogen. There is inhibition of catalase induction with 8-azaguanine and uracil antagonists. The inhibition due to 8-azaguanine could be reversed by addition of an RNA-hydrolysate to the aeration medium, this effect being less with delayed addition of the latter.

Although there is a net increase in RNA content of the cell on aeration, the involvement of RNA in catalase induction is inferable from studies with phosphate starved cells and from incorporation of glycine-2-C into RNA and protein.

Influence of utilizable nitrogenous constituents on induced catalase synthesis in yeast, by Bhuvaneswaran, C., Sreenivasan, A. and Rege, D. V., *Ebzymologia*, 1961, **23,** 15-VIII, 194.—Catalase induction in aerated cultures of *Saccharomyces cerevisiae* grown under anaerobic conditions is inhibited on inclusion of RNA, casein hydrolysate or an amino acid mixture cysteine or EDTA. The inhibition due to casein hydrolysate, cysteine and EDTA could be partially reversed to varying degrees by addition of iron salts. It is suggested that catalase biosynthesis is of secondary significance under nutritional conditions favourable for active cell multiplication.

An air-flow indicator to aid in fumigant sampling, by Muthu, M., *J. Econ Entom*, 1961, **54** (5), 1064.—When drawing fumigant samples there is a danger of taking incomplete samples because it is difficult to know where the flow of gas has ceased. The apparatus described in this paper consists essentially of glass or plastic bead inside a glass tube. The bead moves when the gas flows, even at the rate of 30 c.c. per min. The gadget would be a useful attachment to fumigant chambers containing cereal products. —K.M.D.

PART II (Indian)

BIOCHEMISTRY AND NUTRITION

Effect of protein supplementation to the nursing mothers on some milk constituents: casein and xanthine oxidase, by Belavady, B., *Indian J. med. Res.*, 1962, **50** (1), 100.—The effect of protein supplementation on the casein: total protein ratio and xanthine oxidase activity was studied. There was no change in the casein: total protein ratio after supplementation. Xanthine oxidase activity was increased after protein supplementation. The interrelationship between protein concentration and xanthine oxidase activity in milk has been discussed.

Riboflavin requirement of nursing mothers, by Belavady, B., *Indian J. med. Res.*, 1962, **50** (1), 104.—The effect of supplementing riboflavin to the mother on the concentration of milk was studied in 10 women belonging to the low socio-economic group. The lowest level of riboflavin necessary to maintain and sustain the maximal concentration of the vitamin in milk appeared to be about 3 mg. daily.

Energy metabolism in undernourished subjects before and after rehabilitation, by Ramanamurthi, P. S. V., Srikantia, S. G., and Gopalan, C., *Indian J. med. Res.*, 1962, **50** (1), 108.—Basal metabolic rate was found to be lowered during undernourished states and tenced to rise with nutritional rehabilitation. The absolute energy cost of a sedentary activity, such as sitting and of an exercise over and above basal metabolism did not appear to be significantly altered in semi-starvation. These results indicate that in semi-starvation changes observed in energy expenditure are more due to quantitative changes in metabolising tissue than to qualitative changes in their oxygen requirements.

Effects of tetracyclines on carbohydrate and lipid metabolism by Sachchidananda Banerjee, Prasannan, K. G. and Ghosh, P. K. *J. sci. industr. Res.*, 1962, **21C,** (1), 13.—Glucose tolerance has been found to diminish in rabbits and rats after the animals are fed terramycin, 5.7 mg./100 g. body weight/day, for six days. Liver glycogen has also been found to diminish in rats under terramycin treatment. No such effects are observed in rats similarly treated with achromycin. There is an increase in the cholesterol content of the whole body in the case of rats treated with terramycin or achromycin indicating increased formation of cholesterol after the administration of the antibiotics. Phospholipid content of various tissues increases after treatment of the rats with terramycin or achromycin, although the phospholipid turnover of the whole body does not change.

Cutaneous lesions in *kwashiorkor:* A histopathological and histochemical study by Rangam, C. M., Bhagwat, A. G. and Gupta, J. C., *Indian J. med. Res.*, 1962, **50** (2), 184.—Skin biopsies from 31 children with typical cutaneous lesions of *kwashiorkor* and 10 normal healthy skins have been studied histopathologically and histochemically. The selection of cases was done on the basis of characteristic clinical manifestations and hypoalbuminemia. Histologically, the most striking feature in the epidermis was atrophy. The various patterns observed are discussed. The dermal changes are also recorded. The principle histochemical findings consisted of a qualitative reduction in total and differential nucleoproteins and increase of alkaline phosphatase in the skin lesions. Quantitative reduction in ascorbic acid content of skin has also been observed. Serum levels of vitamin A and C also showed marked reduction. An attempt has also been made to explain these changes on the basis of multiple deficiencies. The differences between these lesions and those observed in pellagra are discussed.

Electrophoretic pattern of serum proteins in oedema complicating protein and calorie malnutrition in adults, by Srikantia, S. G. and Jacob, C. M., *Indian J. med. Res.*, 1962, **50** (2), 238.—Electrophoretic pattern of sera from 16 normal subjects and 20 subjects with nutritional oedema has been determined. The changes induced by nutritional rehabilitation were also studied. The electrophoretic pattern in the subjects with oedema showed a lowering of albumin, a small increase in the α globulins and a considerable increase in the γ globulins. β_2 globulins appeared in some subjects with nutritional oedema during therapy, which, however, disappeared with continuation of treatment. Treatment with high protein diet reversed these changes usually by the end of four weeks. There was no difference between patients treated with and without a supplement of 30 g. milk protein, with respect to the changes brought about in the pattern. The significance of these findings has been discussed. Determinations carried out on the same samples by chemical and electrophoretic methods, showed that electrophoretic method employed here, overestimated albumin, more so, when the albumin levels were low.

Effect of dietary protein on enzymes of liver cell fractions by Rao V. S. and Tulpule, P. G., *Indian J. med. Res.*, 1962, **50** (2), 267. —The activities of cytochrome *C* oxidase in mitochondria, glucose-6-phosphatase in microsomes, fructose 1:6 diphosphatase in ground plasma of liver cells and succinic dehydrogenase in whole liver homogenate have been studied at weekly intervals for eight weeks in young and adult rats fed low protein and adequate protein diets. The results have been expressed on the basis of the activity per mg. of fresh tissue and the activity per mg. of nitrogen.

The loss of total nitrogen of the liver cell fractions of protein deficient rats showed different trends in different fractions. The microsomal fraction lost nitrogen gradually as the deficiency advanced and reached the maxima after 5 weeks, whereas in the case of mitochondria and the supernatant ground plasma the nitrogen fell appreciably in the initial stages. The changes in young and adult rats were almost identical.

Both in young and adult rats, protein depletion decreased the enzyme activity of liver (on fresh weight basis) in all the enzymes except cytochrome *C* oxidase of mitochondria. Succinic dehydrogenase activity of whole liver dropped to nearly 60 per cent in one week. Glucose-6-phosphatase of microsomes followed almost similar pattern, but the changes were less severe. In fructose 1:6 diphosphatase of ground plasma the changes began to show up only after 14 days. It was suggested that protein depletion affected the enzymes of particulate fractions of the liver cells more rapidly as compared to the enzymes of ground plasma.

Based on liver nitrogen, the enzyme activities of all the fraction of the liver cells of protein deficient animals were initially higher than the control groups. The decrease in enzyme activity per unit of nitrogen after prolonged protein deficiency indicated that at a certain stage the enzyme proteins were lost more rapidly than were the total proteins. The loss of enzyme proteins in relation to total proteins was seen earlier in young rats than in adult rats.

DAIRY

Studies on the composition of liquid and solid fractions of the same ghee, by Mitra, S. N. and Bose, P. K., *Curr. Sci.*, 1962, **31** (2), 62.—The authors have conducted analysis of solid and liquid fractions which separate when some samples of *ghee* are allowed to stand, at laboratory temperature. It has been observed that the Reichert of the liquid fraction is invariably higher than that of the solid fraction, while B. R. which remains practically unchanged in the two fractions is almost the same as that of the entire sample.

—B.V.S.

FRUITS AND VEGETABLES

Role of dissolved oxygen of water in the oxydative decomposition of ascorbic acid: a suggested method of boiling to protect ascorbic acid contents of vegetables from oxidative decomposition, by Roy, J. K. and Biswas, S. K., *Indian J. med. Res.*, 1962, **50** (2), 259.—Dissolved oxygen of cooking water has been found to be responsible for bringing about partial destruction of ascorbic acid content of vegetables cooked by boiling. A modified method of boiling based on a simple laboratory experiment has been developed to protect the vitamin completely from the oxidative decomposition. It has been found that the oxidative destruction can be stopped completely if dissolved oxygen of cooking water is first expelled by boiling and cut vegetables to be cooked are added to this oxygen-free boiling water and the boiling is continued under a lid. It is suggested that tribal people in certain regions of

India who cook vegetables by boiling in a rather large quantity of water, can fruitfully apply this method of boiling vegetables to get the full benefit of the ascorbic acid content of vegetables.

Isolation of mucic acid from the fruits of *Emblica officinalis*, gaertn, by Soman, R., and Pillay, P. P., *Curr. Sci.*, 1962, **31** (1), 13.—*Emblica officinalis*, gaertn (Amla) yield a large quantity of mucic acid. It can be isolated by extracting the pulp of the pericarp with caustic soda (pH 8) and subsequent acidification of the alkaline filtrate. Details regarding isolation and confirmation of the substance are given.

—B.V.S.

Ascorbic acid content of west Indian cherry (Malphigia punicifolia L) by Madava Rao, V. N. and Abdul Khader, J. B. M. Md., *Curr. Sci.*, 1962, **31** (3), 114.—Two distinct types of west Indian cherry introduced from U.S.A. in 1958, as seedlings have been analysed for their ascorbic acid content by the 2, 6—dichlorophenol indophenol titration method. This fruit is found to be far superior to the gauva as a potential source of vitamin C and even to the Indian gooseberry (*Phyllanthus emblica*, L). Brief details regarding its habitat, ways of consuming and yield of ascorbic acid are given.

—B.V.S.

GENERAL

Synthesis of 5-dehydroshikimic acid from carbohydrates by mung bean (*Phaseolus aureus*) **seedling extract,** by Nandy, M., and Ganguli, N. C., *J. sci. industr. Res.*, 1962, **21C** (2), 34.—Synthesis of DHS from phosphorylated carbohydrates has been demonstrated in an extract of *mung* bean seedlings. Among the substrates tested, G-6-P and E-4-P with PEP synthesize DHS better and maximum synthesis is obtained with the latter combination. Inhibition and activation studies indicate that G-6-P, by its utilization *via* glycolytic and pentose phosphate pathways, gives rise to DHS. Tests with subcellular fractionation of the *mung* bean seedling extract have shown that micro-somes and supernatant are needed: for G-6-P, the supernatant alone is able to convert E-4-P plus PEP to DHS and mitochondria is inactive in this respect. Seedling germinated in glucose medium is a better source of these enzymes. The conversion of sugar phosphates to DHS by the *mung* bean seedling extract in relation to the existing pathways in *Esch. coli* has been discussed.

PART III (Foreign)

ANALYTICAL

The colorimetric reaction between vitamin A_2 aldehyde and antimony trichloride, by Plack, P. A., *Biochem. J.*, 1961, **81** (3), 556. —Crystalline vitamin A_1 aldehyde with m.p. 66-68° has been prepared from vitamin A_1 aldehyde.

With purified antimony trichloride, 14 per cent (w/w) in chloroform containing 2 per cent (v/v) acetic anhydride, the wave-length of maximum absorption of the green-blue colour produced with vitamin A_2 aldehyde increased with concentration of the aldehyde and decreased with time.

In the absence of acetic anhydride the wave length of maximum absorption of the colour product was steady at 741 mμ, the colour developed remained at full intensity for about 15 sec., the maximum extinction varied linearly with concentration of 1 % aldehyde and E (741 mμ) was 4200 (range 4000-4400).

Some observations on antimony pentachloride and glycerol dichlorohydrin (1:3-dichloropropan—2-ol) as colorimetric reagents for vitamin A_2 aldehyde are presented.

The assay of insulin solutions by paper chromatography, by Fenton, E. L., *Biochem J.* 1961, **81,** (3), 570.—A method for the assay of insulin solutions by ascending paper chromatography is described. The solutions, after desalting and concentration are applied to papers which are developed in the upper phase of butan-2-ol-1 per cent acetic acid (1:1, v/v), then stained with bromocresol green. The dye is eluted and its concentration measured in a spectrophotometer with respect to standards run simultaneously. Treatment of the data as a four point slope ratio assay gave results in good agreement with those obtained on the same solutions by the mouse convulsion method.

Solutions of four-times-recrystallized insulin, stored in the frozen state for use as working standards, remained stable for periods up to 8 weeks at—30° and could be refrozen and thawed up to 30 times in the presence of phenolic preservative without detectable loss of potency.

Gas-liquid chromatographic studies on the enzymatic formation of volatile compounds in raspberries, by Weurman, C. *Food Technol.*, 1961, **15** (12), 531.—Head space sampling over enzyme-substrate reaction mixtures and subsequent analysis by gas-liquid chromatography were shown to be valuable in quantitative enzyme studies when volatile reaction products are involved. An enzyme mixture and a mixture of nonvolatile substrates containing precursors of volatile compounds were prepared from different parts of ripe and unripe raspberries. Their interaction under controlled conditions was shown by gas liquid chromatographic analysis to produce a number of volatile compouds. Simultaneously, the characteristic odour of raspberry developed. Information on the enzymes and on the precursors of the volatile compounds in the substrate mixture was obtained by studying the formation of volatile compounds when enzymes from different sources were added to the substrates. No odour of raspberries developed in these experiments. It could be shown that very likely more than one enzyme acting on nonvolatile substrates, is responsible for the formation of volatile compounds in raspberries.

Apparatus for determining dissolved and dispersed gas content of foods, by Emard H. Sheets and Anthony Lopez, *Food Technol.*, 1962, **16** (1), 64.—An apparatus was developed for rapid gasometric determination and quantitative analysis of the total dissolved and dispersed gas content of certain canned foods and other packaged and fresh foods. The method essentially involves drawing the sample into the evacuation chamber, extracting the gases therein under reduced pressure, collecting the gases extracted, and performing a differential gas analysis through the use of absorbing reagents. Statistical evaluation of the apparatus indicated a relatively high degree of sensitivity and reproducibility. The standard deviation about the mean was 0.0374 ml. of gases per 100-g. sample and 95 per cent confidence limits were 4.06 and 4.12 ml. per 100-g. sample.

The method was found to be applicable to foods of varying consistency, fluidity, and viscosity.

Application of centrifugal method for measuring shrinkage during thawing and heating of frozen cod fillets, by David Miyauchi, *Food Technol.*, 1962, **16** (1), 70. A centrifugal method for measuring shrinkage of meats during freezing, thawing, and heating was adapted for fish. The precision of the results was satisfactory considering the heterogeneity of the raw material. Use of centrifugal method in studies with Pacific cod (*Godus macrocephalus*) fillets gave the following results: 1. Agreement of thaw-drip determinations between two fillets from the same fish was good; however variation was considerable among fish. 2. During storage at 0°F, the cook-drip increased by a small but significant amount during the first several months and then remained almost constant throughout the 12-month test period. 3. Thaw-drip and cook-drip increased with storage temperature.

ANTIOXIDANTS

Their use in food and animal feeds, by Wright, R. B., *Food Manuf.*, 1962, 37 (1), 5.—Although antioxidants are widely used in the chemical field, particulrly in petroleum and rubber technology, their use in food has for obvious reasons grown at a very much slower rate, and only recently has legislation allowed their more extensive use for this purpose. After discussing the mechanism of oxidation in general and the way in which antioxidants act, the author reviews the uses of antioxidants in food and animal feeds and briefly summarises current legislation.

Evaluation of gentisic acid and sodium gentisate as food antioxidants, by Theodore Wishnetsky and Ben N. Stuckey, *Food Technol.*, 1961, **15** (12), 503.—The effectiveness of gentisic acid (2, 5-dihydroxybenzoic acid) and its sodium salt as antioxidants for several types of foods and inedible fats was investigated. In lard, cottonseed oil, fish oil and grease, stability was judged by the active oxygen method, and carry-through stability was measured by the oxygen bomb technique. Storage stability of essential oils was determined by organoleptic, colour, and peroxide evaluations. Stability of frozen frankfurters and frozen uncured bacon belly was evaluated by the thiobarbituric acid method. Results indicate that gentisic acid and sodium gentisate are potentially useful antioxidants for a variety of foods.

The use of antioxidants in canning apple halves, by Hope, G. W., *Food Technol.*, 1961, **15** (12), 548.—When apple halves were canned without oxygen removal the headspace of the can contained 10-12 volume per cent oxygen. The addition of ascorbic acid at 300 mg. per lb. of fruit controlled browning, reduced headspace oxygen, protected the container from corrosion and increased the residual ascorbic acid content.

BIOCHEMISTRY AND NUTRITION

Influence of autoclaving soybean proteins on liberation of aspartic and glutamic acids and lysine by several digestion procedures, by Robert John Evans, Selma L. Bandemer and Doris H. Bauer, *J. Fd. Sci.*, 1961, **26** (6), 663.—Part of the lysine was destroyed when soybean meal or isolated soybean protein mixed with sucrose was autoclaved 4 hour at 121°C. Little or no loss occurred when isolated proteins were autoclaved by themselves.

In vitro digestion with trypsin and repsin liberated less lysine from the autoclaved than from the unheated soybean proteins if they did not contain the trypsin inhibitor.

Partial hydrolysis with hydrochloric acid liberated more aspartic and glutamic acids and lysine from unheated than from heated soybean proteins.

Hydrolysis with concentrated hydrochloric acid for 7 days at 40°C and *in vitro* digestion with trypsin and repsin liberated similaramounts of lysine (except for the proteins containing trypsin inhibitors), but acid hydrolysis liberated more aspartic and glutamic acids than did enzymatic hydrolysis.

The data support the hypothesis that autoclaving soybean protein formed lysine-aspartic acid and lysine-glutamic acid linkages that were resistant to mild hydrolysis.

Isolations and some properties of native lipoproteins from egg yolk, by Hiroshi Sugano and Iku Watanabe, *J. Biochem.*, 1961 **50** (6), 473.—1. The isolation methods of two groups of native lipoproteins (having 84 and 20 per cent lipids) from egg yolk were described.

2. Physical measurements, chemical analysis, and solubility examinations were performed on these preparations.

3. Ultracentrifugal and electrophoretic studies found that each lipoprotein fraction consists of two species of lipoproteins,respectively.

4. The proportions of four lipoproteins, phosvitin, and livetins in the egg yolk were roughly estimated on the basis of the ultracentrifugal analysis.

5. The native lipoproteins obtained here were discussed comparing with the components reported by the previous workers.

Alternative pathways of carbohydrate metabolism in foetal and adult tissues, by Villee, C. A. and Loring, J. M., *Biochem. J.*, 1962 **81** (3), 488.—1. Tissue slices were incubated with (1-^{14}C)-glucose and (6-^{14}C) glucose to evaluate the relative rates of glycolysis and the hexose monophosphate oxidative pathway in a variety of foetal and adult tissues.

2. The effects of anaerobiosis and of the addition of unlabelled pyruvate, D-2-deoxyglucose, ascorbate, and di- and tri-phosphopyridin nucleotide were tested.

3. There was no significant change in the relative rates of metabolism *via* these two alternative pathways of carbohydrate metabolism in any of the tissues over the period of foetal development from 8 to 25 weeks' gestational age.

4. The activity of the hexose monophosphate pathway in different tissues ranged from the foetal cerebral cortex, in which it is essentially zero, to the adrenal cortex, in which it accounts for most of the glucose metabolized. Comparative studies, however, revealed wide differences in the relative activities of the two pathways in comparable tissues of different species.

Interrelationships in trace-element metabolism in *Aspergillus niger*, by Adiga, P. R., Sivarama Sastry, K., Venkatasubramanyam, V. and Sarma, P. S. *Biochem. J.*, 1961, **81** (3), 545.—1. Cobalt, nickel and zinc toxicities have been studied in detail in the mould *Aspergillus niger* from the point of view of their adverse influence on growth, acid formation and over-all glucose utilization. At toxic concentrations, all these parameters were impaired to different degrees at various metal concentrations.

2. The counteracting effect of iron and magnesium when supplemented with the toxic metals has been examined. Either of these metals could overcome growth inhibition completely, iron at concentrations uniformly in the range 160-200 μg./ml. of culture medium, and magnesium at concentrations varying markedly with the metal toxicity involved. Only magnesium supplementation permitted normal sporulation concomitantly with growth.

3. Magnesium restored growth, acid formation and glucose utilization to normal levels in all cases except in cobalt toxicity, where it had no influence on acid formation and promoted glucose consumption only to the extent of about 87 per cent of the control. Iron reversed the impaired glucose utilization partially in cobalt toxicity alone. In all toxicities it was ineffective with regard to acid production.

4. The results have been discussed, and it has been suggested that zinc toxicity corresponded to a conditioned magnesium deficiency and that due to cobalt, to an iron deficiency.

Techniques for the fractionation of microbiologically active peptides derived from casein, by Phillips, A. W. and Gibbs, P. A., *Biochem. J.*, 1961, **81** (3), 551.—1. Columns of sephadex G-25 have been used for the preliminary fractionation of tryptic digests of casein.

2. Fractions from sephadex columns have been examined for their ability to stimulate the growth of a strain of *Streptococcus equisimilis*. Maximum stimulatory activity appeared to be localized in a fairly narrow region of the total peptide material.

3. Further fractionation of peptides derived from casein has been achieved by subjecting fractions from columns of sephadex to two-dimensional separations involving the successive use of paper chromatography and high-voltage electrophoresis. Over one hundred spots due to peptides have been detected.

Intestinal synthesis of riboflavin in the rat, by Faulkner, R. D. and Lambooy, J. P., *J. Nutr.*, 1961, **75** (4), 373.—The regression equation for the accumulation of riboflavin in the 'system' for the riboflavin-deficient rat, as estimated from the variation of tissue, urine and fecal riboflavin less the riboflavin in the diet with time, showed that the rate of accumulation is 1.94 +0.28 μg per day per rat. This is approximately equal to the rate of fecal excretion of riboflavin. The fecal excretion of riboflavin is seen to be superimposed on a relatively constant riboflavin content of the tissues and of constant excretion of riboflavin in the urine.

The rate of destruction of riboflavin was obtained from the slope of the regression equation for the variation of tissue C^{14} riboflavin with time, and observed to be -1.26 +0.21 μg per day per rat.

The correction of the rate of accumulation of riboflavin in the 'system' by use of the rate of destruction results in a value for the total rate of synthesis of riboflavin of 3.2×0.12 μg per day in the riboflavin-deficient rat.

Effect of mild chemical and enzymatic treatments of soybean meal and soybean trypsin inhibitors on their nutritive and biochemical properties, by Yehudith Birk and Arieh Gertler, *J. Nutr.*, 1961, **75** (4), 379.—Raw soybean meal (RSBM) was extracted with HCl (pH 4.2) yielding an insoluble residue ($SBM_{4\cdot 2}$) with a higher protein content. Although $SBM_{4\cdot 2}$ retained about 50 per cent of the original RSBM trypsin-inhibiting activity and almost no hemagglutinating activity, it was only slightly superior to RSBM when added to diets of chicks and rats.

Fraction $F_{4\cdot 2}$, the acetone precipitated and vacuum-dried extract (pH 4.2) of RSBM, when added to a properly heated soybean meal diet impaired growth only to the extent of one-third of the growth-impairment caused by $SBM_{4\cdot 2}$ although $F_{4\cdot 2}$ contains about 50 per cent of trypsin-inhibiting and most of the hemagglutinating activities of RSBM.

The stability of the trypsin-inhibiting and hemagglutinating activities of RSBM, $SBM_{4\cdot 2}$ and three crude soybean trypsin inhibitors towards HCl (pH 1.6) and peptic digestion were examined in an attempt to elucidate the fate of the two detrimental activities prior to pancreatic digestion. Analysis of residual trypsin-inhibiting and hemagglutinating activities showed that hemagglutinating activity was completely destroyed even when incubated with HCl alone, whereas trypsin-inhibiting activity was destroyed to a varying extent, depending upon the material examined. The trypsin-inhibiting activity of $SBM_{4\cdot 2}$ was found relatively more resistant towards HCl and pepsin, thus leading to the conclusion that its higher than expected growth-depressing activity might be due partly to the presence of a comparatively more resistant trypsin inhibiting activity.

Growth experiments with chicks maintained with diets including RSBM, $SBM_{4\cdot 2}$ and properly heated soybean meal supplemented by various methionine levels showed no interaction between the various soybean meals and the level of methionine added.

Amino acid imbalance: rations low in tryptophan, methionine or lysine and the efficiency of utilization of nitrogen in imbalanced rations, by Hans Fisher and Shapiro, R., *J. Nutr.*, 1961, **75** (4), 395.—Three experiments were conducted with growing chickens. In the first and second of these, an amino acid imbalance (deficiency) was created with rations low in tryptophan or methionine. In the third experiment, diets containing three levels of energy were formulated in such a manner that birds consumed equal quantities of food and therefore of protein and of the most limiting amino acid (lysine) when fed rations that were either imbalanced or balanced. This permitted a comparison of the efficiency of utilization of the protein and of the most limiting amino acid. No impairment in utilization occurred in terms of either body weight gain or carcass nitrogen content of birds fed imbalanced versus normal rations. The results indicate that the term imbalance as used in its present context cannot be differentiated from an amino acid deficiency.

Studies on the combined and relative influence of dietary protein and riboflavin in flavoprotein enzymes, by Ramakrishnan, S., Srinivasan, V. and Nedungadi, T.M.B., *J. Nutr.*, 1961, **75** (4), 443.—1. Xanthine oxidase and D-amino acid oxidase activities were determined in the livers of 8 groups of rats with 5, 18, 40 and 60 per cent of devitaminized casein with and without added riboflavin.

2. Both xanthine oxidase and D-amino acid oxidase activities of rat liver were reduced to the minimum in a combined deficiency of dietary protein and riboflavin.

3. Xanthine oxidase activity depended much more upon protein (casein) than upon riboflavin, where as D-amino acid oxidase activity depended more upon riboflavin than upon protein.

CEREAL PRODUCTS

An investigation of varietal differences in the iodine-binding capacities of crystalline rice amyloses, by Allen T. Phillips and Virginia R. Williams, *J. Food Sci.* 1961, **26** (6), 573.—Purified amyloses have been obtained from four widely different varieties of rice by alcohol fractionation of the corresponding starch. Each variety of amylose was found to bind 18.9 mg. of iodine per 100 mg. of amylose on the basis of solvent-free carbohydrate. Viscosity measurements in potassium hydroxide solutions have made possible the calculation of the viscocity-average molecular weights. These molecular weights were found to be: Century Patna 231, 100,000; Caloro, 140,000; Rexoro, 325,000; and Zenith, 310,000. Beta-amylase action on Century Patna and Rexoro amyloses indicated that the structures of both were similar.

Volatile organic acids in preferments for bread, by Irving R. Hunter, Hawkinsng, and James W. Pence, *J. Food Sci.*, 1961, **26** (6), 578.—An ionization-detector gas chromatographic unit was used to analyze the acids extracted from a pre-ferment typical of those used in commercial bread-making. At least 45 acids were separated as esters on a column containing an adipate polyester of diethylene glycol. Seventeen of the monocarboxylic acids were identified by relative retention times in free acid form. Their identities were confirmed by preparing and separating their esters directly by flash exchange gas chromatography. The acids thus identified are: formic, acetic, propionic, isobutyric, butyric, isovaleric, valeric, crotonic, isocaproic, caproic, heptylic, caprylic, pelargonic, capric, lauric, myristic, and palmitic.

The sedimentation test, by Roy K. Durham, *Cereal Sci. Today*, 1962, **7** (1), 13.—Sedimentation value indicates only the *maximum potential* bread-baking strength of wheat. Sedimentation value is certainly not a single figure that can be substituted for the various assorted baking tests that are commonly employed in mill and bakery laboratories. The ordinary bread-baking test is not intended to measure *maximum potential* bread-baking strength. Inherent gluten strength in wheat is revealed by the sedimentation test, unobscured by the oftentimes misleading baking results.

Determining damage in yellow corn, by Robert M. Johnson, *Cereal Sci. Today*, 1962,

7 (1), 15.—Some kernels of corn which a grain inspector considers as damaged are often extremely difficult to detect by a quick visual examination. Mold growing within the germ is not readily apparent to the naked eye. Therefore, this objective, rapid, light-absorption difference method, which determines internal as well as external damage in corn, is more accurate than the subjective visual method now employed.

Fat acidity did not correlate as well as per cent of damage with mater readings. This may be due to the fact that different types of damage have varying effects on fat acidity.

Another application for this rapid method would be the determination of hidden damage in wheat, particularly 'sick wheat', since this type of damage can be detected absolutely only by removing the germ layer. This work is now being pursued.

DEHYDRATION

Determination of moisture equilibria in dehydrated foods, by Taylor, A. A., *Food Technol.*, 1961 **15** (12), 536. A method of evaluating the relations between equilibrium relative humidity (ERH) and-moisture content by vapor-pressure measurement has been used to give data on dehydrated foods. The technique is rapid and allows several determinations to be carried out on the same sample at various moisture levels. The method also has potential application as a rapid moisture-determination method giving results after observation of 1 hr. ERH is much more indicative of the behaviour of the food with respect to its moisture than is the moisture content. Data for a variety of accelerated freeze-dried foods have been obtained that are applicable to dehydration and storage problems and have indicated that the apparatus could be very suitable for further study of the behaviour of water in dried foods.

A study of the mechanism of fruit and vegetable dehydration, by Saravacos, G. D. and Charm, S.E. *Food Technol.*, 1962, **16** (1), 78.—Four vegetables and four fruits were dehydrated in an air dryer, and drying-rate curves were constructed. Constant-rate periods were found in most materials, and the critical moisture contents were characteristic for each food and for given drying conditions. The drying data followed the equation in

$$\frac{W - W_e}{W_c - w_e} = - m$$

in the region of moisture contents $W = 1.0$ to 0.1, and the values of the drying constant (m) were determined for a set of conditions.

A study was made of the effect of the air-drying conditions and the size of the material on the drying rate of potatoes. A small increase in drying rate during the constant-rate period was effected by increasing air velocity or decreasing air humidity, but these variables did not affect the falling-rate period. The drying time was found to be proportional to the square of the thickness of the potato slabs. Blanching potatoes before dehydration had no effect on drying rate. These results suggested that moisture transfer during the falling-rate period in potatoes is by molecular diffusion. The diffusivity of moisture in the potato was calculated, and it was found to increase with temperature, following the Arrhenius equation.

Effect of surface-active agents on the dehydration of fruits and vegetables, by Saravacos, G. D. and Charm, S. E., *Food Technol.*, 1962, **16** (1), 91.—Treatment of porous fruits (e.g., apples and peaches) with surfactants before dehydration was found to increase the drying rate during the early period of drying (constant-rate period). There was no significant effect of the surfactants on the drying rates of vegetables (potatoes, carrots, onions, garlic) and seedless grapes. In all cases the surfactants had no effect on the falling-rate period of drying. The equilibrium moisture contents and the rehydration ratios of the fruits and vegetables studied were not affected in general by the surfactant pretreatment. The shrinkage properties of potatoes and apples during dehydration were unaffected by the surfactants.

DAIRY PRODUCTS

Copper and iron content of ice cream and mellorine and its significance in the development of oxidative flavour defects, by Vanderzant, C. and Miah, A. H., *Food Technol.*, 1961, **15** (12), 515.—An analysis of 107 samples of ice cream and mellorine showed that the chocolate-flavoured samples usually contained more copper and iron than the vanilla or strawberry samples. The means of copper content of the vanilla, strawberry, and chocolate samples were respectively 0.305, 0.390 and 1.160 ppm. No relation could be established between oxidative flavour defects and the copper or iron content of the samples. The addition of 0.82 ppm of copper after homogenization caused a metallic flavour in vanilla ice cream after 11 days of storage at -25°C. When copper was added before homogenization the rate of development of oxidative flavour defects was much slower. Iron did not seem to be involved in the development of a metallic off-flavour.

FATS AND OILS

Hydrogenated fats in the diet and lipids in serum of man, by Joseph T. Anderson, Francisco Grande and Ancel Keys, *J. Nutr.*, 1961, **75** (4), 388.—Selectively hydrogenated oils were exchanged for the corresponding natural oils in the diet of physically healthy men in a mental hospital. In 27 men a mean rise of 10 mg. of cholesterol per 100 ml. of serum resulted from the exchange of hydrogenated for natural safflower oil fed at the level of 30 g in the daily diet. In 12 men similar exchange of those oils at the level of 100 gm daily produced a mean rise of 25 mg. of cholesterol per 100 ml. In 13 men substitution of hydrogenated for natural corn oil fed at the level of

100 g. daily produced a mean rise in cholesterol of 21 mg. per 100 ml.

In another experiment on 23 men the variable in the daily diet was 95 g. of fat, comparison being made between a mixture of natural vegetable oils and a hydrogenated product with the same proportions of saturated, monoene and diene fatty acids but containing 36 per cent of *trans* monoene and 12 per cent of *trans* or conjugated diene. The hydrogenated fat produced mean rises, per 100 ml. of serum, of 21, 18, and 61 mg. of cholesterol, phospholipids, and triglycerides, respectively.

FRUIT AND VEGETABLE PRODUCTS

The volatile constituents of passion fruit juice, by Hiu, D. N. and Scheuer, P. J., *J. Food Sci.*, 1961, **26** (6), 557.—The characteristic flavour of passion fruit was found in the water-insoluble oil, which constituted ca. 36 ppm of the juice. Four components, *n*-hexyl caproate, *n*-hexyl butyrate, ethyl caproate, and ethyl butyrate, made up ca. 95 per cent of the oil, and, among these four, *n*-hexyl captoate was found to be the principal component, accounting for ca. 70 per cent of the volatile passion fruit essence.

The unidentified portion of the oil (ca. 5 per cent) very likely contains compounds of greater structural complexity than those identified. Evidence for this assumption comes from the appreciable specific rotation of the crude oil. It is also reasonable to assume that the olefinic unsaturation encountered in the crude oil has its origin in the unidentified portion of the oil.

Volatile esters of Bartlett pears by Jennings, W. G., *J. Food Sci.*, 1961, **26** (6), 564.—Esters are responsible for the typical desirable aroma of Bartlett pear. Hydrolysis products of these esters were resolved by gas chromatography. The major ester acid is an unsaturated 10 carbon acid, which hydrogenates to yield *n*-capric acid, as identified by relative retention volume and infra-red spectroscopy. Nonanoic acid is present in relatively large amounts, and smaller amounts of acetic, propionic, butyric, caproic, and caprylic acids are involved. The major ester alcohols include *n*-butyl alcohol and *n*-hexyl alcohol. Two other still unidentified alcohols possibly polyfunctional or cyclic, occur in large amounts. The author was unable to find evidence of ethyl esters.

Volatile flavour of Sauerkraut. Gas chromatographic identification of a volatile acidic off-odour, by Vorbeck, M. L., *et al.*, *J. Food Sci.*, 1961, **26** (6), 569.—A method is presented for gas chromatographic identification of the chain length and structure of methyl esters of lower-molecular-weight fatty acids. The chemical identity of the 'cheese-like' off-odour of sauerkraut was established. Abnormally high concentrations of *n*-propionic, *n*-butyric, and *n*-caproic acids were found in samples of kraut that had been graded low because of this off-odour defect. A very poor sample that had been discarded, contained isobutyric and isovaleric acids in addition to *n*-propionic, *n*-butyric, *n*-valeric, and *n*-caproic acids. In this sample, *n*-butyric acid was found in the largest concentration—103 ppm.

Effect of temperature and holding period on some physical and chemical characteristics of lemon fruits, by Eaks, I. L. *J. Food Sci.*, 1961, **26** (6), 593.—Changes were followed in fresh weight, juice content, soluble solids, total acidity, and ascorbic acid of lemon fruits during 4, 8, and 12 weeks at 4, 13, and 24°C and after 3 and 14 days at 24°C following 4, 8, and 12 weeks at 4 and 13°C. Juice content, soluble solids, and total acidity increased during storage. The increase was greatest for fruit held at 24°C and least for fruit held at 4°C. Upon transfer to 24°C from 4 and 13°C, all three constituents increased. Changes in ascorbic acid in the lemon fruit do not appear related to the mechanism of chilling injury, but the losses observed in chilled fruit when transferred to 24°C were secondary, probably associated with symptom development.

Probable identity of the pectinase inhibitor in grape leaves, by Porter, W. L. and Schwartz, J. H., *J. Food Sci.*, 1961, **26** (6), 600.—Studies were continued on the chemical nature of the water-soluble substance in Muscadine grape leaves that was previously reported as inhibiting pectinase and cellulase. The inhibitor is a tannin or tannin-like material, removable from leaf extracts by hide powder, caffeine, gelatin, and nicotine sulfate. Muscadine leaves had the highest inhibiting activity of the plants tested.

Taste interrelationships. II. Supra threshold solutions of sucrose and citric acid, by Pangborn, R. M., *J. Food Sci.*, 1961, **26** (6), 648.—The effect of citric acid on the sweetness of sucrose solutions was determined by a highly trained panel using variations of two basic methods: single stimulus and paired stimuli. In the former presentation, evaluation of samples singly or in a series of 4 did not alter responses significantly. The binary method, requiring judges to indicate the direction and the degree to which members of a pair differed in sweetness, was slightly more sensitive than the single presentation, especially when one member of the pair within a set was kept constant. The following conclusions were drawn from all methods: (*a*) citric acid, at concentrations ranging from 0.007 to 0.073 per cent, depressed the sweetness of 0.5-20.0 per cent sucrose, (*b*) the masking of sweetness by acid was greater at lower than at higher sucrose concentrations.

The pattern of the soft drinks industry, by O'Donoghue, P. N., *Food Manuf.*, 1962, **37** (2), 53.—Growth, higher quality and increasing mechanisation, both in manufacture and distribution, are the trends in this vigorous industry, whose sales this year, or next may well top the 500 million gallon mark. What this means in terms of drinking habits is analysed in the following review, which also touches on other important aspects including legislation, in which changes affecting the industry are imminent.

Low-temperature handling of sterilized foods. IV. Colour and flavour of canned vegetables, by Joffe, F. M., *et al.*, *Food Technol.*, 1961, **15** (12), 507.—Effects of processing methods on flavour and colour attributes indicate that HTST processing was generally superior to conventional processing and was comparable to or better than frozen storage immediately after the processing. Retention of the advantage was dependent on storage time and temperature. If the storage temperature was maintained at 35-50°F, the HTST samples were preferable to conventional samples for 24 months, and comparable to or better than the frozen samples in all attributes except hue. At 25 and 85°F, however, the retention of favourable colour and flavour attributes rapidly diminished. Flavour degradation was most noticeable in storage at 85°F. Of the products examined, whole-kernel corn appeared best suited for HTST processing.

Low-temperature handling of sterilized foods. VI. Colour and flavour of canned soups, tomato juice, and evaporated milk, by Joffe, F. M., *et al.*, *Food Technol.*, 1961, **15** (12), 510.—Colour and flavour were evaluated for several liqueform products processed by HTST sterilization, conventional canning, and freezing, and stored at 25, 35, 50, and 85°F for 3, 6, 12, 18 and 24 months. Colour was affected most by storage time, the most rapid changes occurring during the first 6 months of storage. Hue was best maintained by freezing; brightness by HTST sterilization. Conventional canning produced the greatest changes in colour due to processing and storage. Flavour was affected most by processing method, with HTST sterilization initially most preferable. Storage at 35°F, was optimum followed by 50, 25, and 85°F respectively.

Spectrophotometric evaluation of anthocyanin pigment development and scald damage in intact red tart cherries, by Yeatman, J. N., *et al.*, *Food Technol.* 1961, **15** (12), 521.—The light-transmittance properties of intact cherries were measured with three new instruments. Optical density differences (△OD) between selected pairs of wavelengths in the region *ca.* 450-800 mμ were explored for indicating scald damage and anthocyanin pigment development. An index of damage, △OD 780-695, is suggested as a good measurement of the scald damage in bruised fruit. This damage was particularly severe in brusied fruit held so that the cherries touched one another, at room temperature (80° F) and in sunlight (90° F plus). The correlation (.83) between anthocyanin content of individual sound cherries and △OD 540-612 was highly significant. A system for intact cherry spectrophotometry should first sort out scald cherries by △OD 780-695 and then measure the colour of individual sound fruit by △OD 540-612.

The effect of bruising and aging on the texture and pectic constituents of canned red tart cherries, by Buch, M. L., *et al.*, *Food Technol.*, 1961, **15** (12), 526.—Red, tart cherries allowed to stand before being canned, either with or without having been previously bruised, were much firmer after canning than were similar cherries canned immediately after harvest. During the aging period a portion of the pectin was completely demethylated to form pectic acid. Most of the pectin, however, was apparently unchanged in chain length or degree of esterification. Histological examination of the tissue showed that the cell walls of the aged cherries were more rigid and less easily separated from each other than were the cell walls of cherries canned immediately after harvest.

Factors affecting the corrosiveness of concentrated tomato products, by Hernandez, H. H., *Food Technol.*, 1961, **15** (12), 543.—Investigation was made of some of the causes for the corrosiveness of tomato paste, besides copper contamination and the products of carmelization (already evaluated). Degradation products of ascorbic acid and demethoxylated pectin were found to accelerate container corrosion when added to tomato paste. Several currently accepted packing practices tend to increase the concentration of these compounds, resulting in a parallel increase in corrosiveness. Three major preparation and packing factors were shown to lead to a shortened service life of canned concentrated tomato products; 1) aeration of the product during manufacture; 2) failure to inactivate the enzymes quickly enough; 3) slow cooling. Of these three, the last had the greatest effect in increasing corrosion.

FISH AND MEAT PRODUCTS

Fatty acid composition of meat tissue lipids, by Hornstein, I., Crowe, P. F. and Heimberg, M. *J. Food Sci.*, 1961, **26** (6), 581.—The lipids extracted from beef and pork muscle were fractionated into triglycerides, cephalins, and a mixture of lecithins and sphingomyelins. The fatty acid composition of these fractions was determined, and the possible effect of phospolipids on meat flavour was evaluated.

Toughness in meat, by Hill, F., *Food Manuf.*, 1961, **36** (12), 511.—Both ante and post mortem factors play a part in the degree of toughness of a meat cut as it reaches the eater. This subject is still far from being completely understood, but the following review surveys our present knowledge of these factors and describes methods of measuring toughness.

Freezing crabs afloat, by Tench, C. V., *Food Manuf.*, 1961, **36** (12), 517.—Quick-freezing within minutes of catching is the secret of the rapid rise to popularity of

Alaska King Crab. This article describes how the shellfish are processed on board a factory trawler.

MICROBIOLOGY

Some characteristics of coagulase-positive staphylococci from market meats relative to their origins into the meats, by Jay, J. M., *J. Food Sci.*, 1961, **26** (6) 631.—From four market meats (hamburger, pork chops, beef liver, and round steak) obtained at 28 retail stores, 136 isolates of coagulase-positive staphylococci were recovered. Suggestive of human sources of *Staphylococcus aureus* to the meats were bacteriophage types of most of the isolates similar to those of human strains. Also, over 70 per cent of the isolates produced hemolysins characteristic of human strains of *S. aureus*. Suggestive of non-human sources was the finding that none of the strains was resistant to penicillin and three other antibiotics and that 6 per cent were resistant to streptomycin, 3 per cent to chlortetracycline, and 12.5 per cent to ristocetin.

Media for detecting pectolytic gram-negative bacteria associated with the softening of cucumbers, olives, and other plant tissues, by King, A. D., Jr. and Vaughn, R. H., *J. Food Sci.*, 1961, 26 (6), 635.—The limitations of eosine methylene blue or basic fuchsin polypectate gels prompted further investigations to develop a selective pectate gel that could be used to enumerate or isolate gram-negative pectolytic bacteria even when they composed a minor portion of the microbial population.

Crystal violet and brilliant green with bile proved the most effective of several selective agents studied. Of the two, crystal violet was much less inhibitory. Actidione, 10 mg. per L, added after sterilisation, is helpful in the control of growth of moulds and yeasts on this medium.

The crystal violet medium has a productivity comparable to that of standard plate-count agar when pure cultures are used. It was successfully used to enumerate known populations of pectolytic gram-negative bacteria among mixed populations of other nonpectolytic gram-negative and positive bacteria. It is also being used routinely for enumeration and isolation of pectolytic gram-negative bacteria from natural sources.

Thus far, pectolytic bacteria belonging to 5 genera, including *Aerobacter*, *Escherichia*, *Paracolobactrum*, *Aeromonas*, and *Achromobacter*, have been isolated by use of the crystal violet gel.

REFRIGERATION

Calculating the keeping quality of frozen foods, by Jul, M., *Food Manuf.*, 1961, **36** (12), 520.—One of the most comprehensive research programmes yet undertaken in the field of food preservation is the Time-Temperature Tolerance Project, the so-called TTT programme, carried out by the Western Regional Research Laboratory of the U.S. Department of Agriculture. The results of these experiments have made it possible to calculate accurately the effects of various storage and handling practices for frozen foods. This article draws a few preliminary conclusions from the various reports regarding the TTT programme, among which is the desirability of establishing three grades of frozen food—those which keep well at all temperatures, those which keep well at low but which are sensitive to high temperatures, and those with low keeping quality at all temperatures. This could mean different storage and handling procedures for these three grades.

VITAMINS

Major dietary constituents and vitamin B_{12} requirement, by Erickson, B.A., and O'Dell, B. L., *J. Nutr.*, 1961, **75** (4), 414.—The effects of the concentration of two major dietary constitutents, protein and fat, and of the type of carbohydrate on the vitamin B_{12} requirement of the rat were investigated. The criteria of adequacy of the diets were growth rate of weanling rats, reproduction and lactation performance of mature females and the incidence of gross malformations among the offsprings. The basal diet contained sucrose, 10 per cent of fat and 30 per cent of soy protein. One diet contained 60 per cent of soy protein, one 30 per cent of fat, one lactose and one glucose. All supplements were added at the expense of sucrose.

The high-protein and high-fat diets slightly increased the growth response to vitamin B_{12}, but the interaction was not statistically significant. High protein decreased reproduction but did not increase the incidence of congenital anomalies. High fat tended to improve the reproduction and lactation performance in the absence of vitamin B_{12}, but had no effect on congenital malformations.

Glucose gave results entirely comparable to those obtained with sucrose. In the absence of vitamin B_{12}, lactose impaired reproduction but tended to decrease the incidence of abnormal offspring.

Metabolic patterns in preadolescent children VI. Vitamin B_{12} intake and urinary excretion, by Ruth M. Feeley and Elsie Z. Moyer, *J. Nutr.* 1961, **75** (4), 447.—The vitamin B_{12} content was determined for each of 6 controlled diets used in a series of metabolic studies with a total of 23 healthy 7-9 year-old girls. Urinary vitamin B_{12} excretions were determined for 11 girls receiving two of these diets that were low in protein.

Diets with a daily average of 48 to 88 g. of total protein (about 65 per cent from animal sources) contained from 3.9 to 4.5 μg of vitamin B_{12} per day. Diets of lower protein content with a daily average of 18 to 22 g. of total protein (about 40 per cent from animal sources) contained 0.7 and 1.1 μg. of vitamin B_{12} per day, respectively.

The urinary excretion of vitamin B_{12} for the girls receiving low-protein diets was 9 per cent of the dietary intake at the initiation of the controlled diet phase of the study and from 3 to 4 per cent in latter phases.

Diets, made up of ordinary foods patterned to meet the Food and Nutrition Board's recommended allowances for children 7 to 9 years of age, supplied about 4 μg of vitamin B_{12} daily.

Pantothenic acid excretion on three levels of intake, by Hazel Metz Fox and Hellen Linkswiler, *J. Nutr.*, 1961, 75 (4), 451.—Urinary excretion of pantothenic acid was measured in response to self-chosen diets and to a controled standardized diet providing 2.8, 7.8 and 12.8 mg of pantothenic acid daily. Each subject was studied for 10 days at each level of pantothenic acid intake following an adjustment period using the standardized diet. Excretion of pantothenic acid responded to changes in intake. The mean excretion on intakes of 2.8, 7.8 and 12.8 mg of pantothenic acid daily was 3.2, 4.5 and 5.6 mg. respectively. Comparison of the excretion of the subjects fed the higher levels of pantothenic acid in different order indicates that urinary excretion may reflect previous dietary intake of the vitamin.

The calculated pantothenic acid content of quantitatively estimated self-chosen diets that were adequate with respect to other nutrients was approximately 7 mg. daily. The mean pantothenic acid excretion by subjects consuming these self-chosen diets was 3.9 mg. daily.

Altering the pantothenic acid intake from 2.8 to 12.8 mg daily did not affect the excretion of other nutrients.

STARCHES

Temperature and the retrogradation of starch, by A. Joseph Kalb and Clarence Sterling, *J. Food Sci.*, 1961, **26** (6), 587.—Corn starch sols (2 per cent) were prepared at a series of gelatinization temperatures (80-127°C) and stored at 1, 37, and 70°C. At 1°C storage, retrogradation was slower as the temperature of gelatinization was greater. At 37°C storage, no retrogradation occurred in samples gelatinized at lower temperatures, and solubilization took place in samples gelatinized at higher temperatures. At 70°C storage, solubilization occurred in all samples, but more rapidly as the temperature of gelatinization was greater.

STATISTICAL

Factor analysis applied to paired preferences among four grape juices, by Baker, G. A., Amerine, M. A. and Pangborn, R. M., *J. Food Sci.*, 1961, **26** (6), 644.—Four grape juices differing in amount of added citric acid were examined by paired comparison by 72 tasters. Some judges preferred sweet and some preferred acid juices, causing pronounced and progressive changes in the frequency distributions of the preference ratings. The correlation coefficient between variances and acid differences was 0.98. The direction and degree of preference was much more consistent for larger difference in acid. Mathematical models developed by other authors for analysis of paired comparison data are of doubtful validity or awkward in application to the present data.

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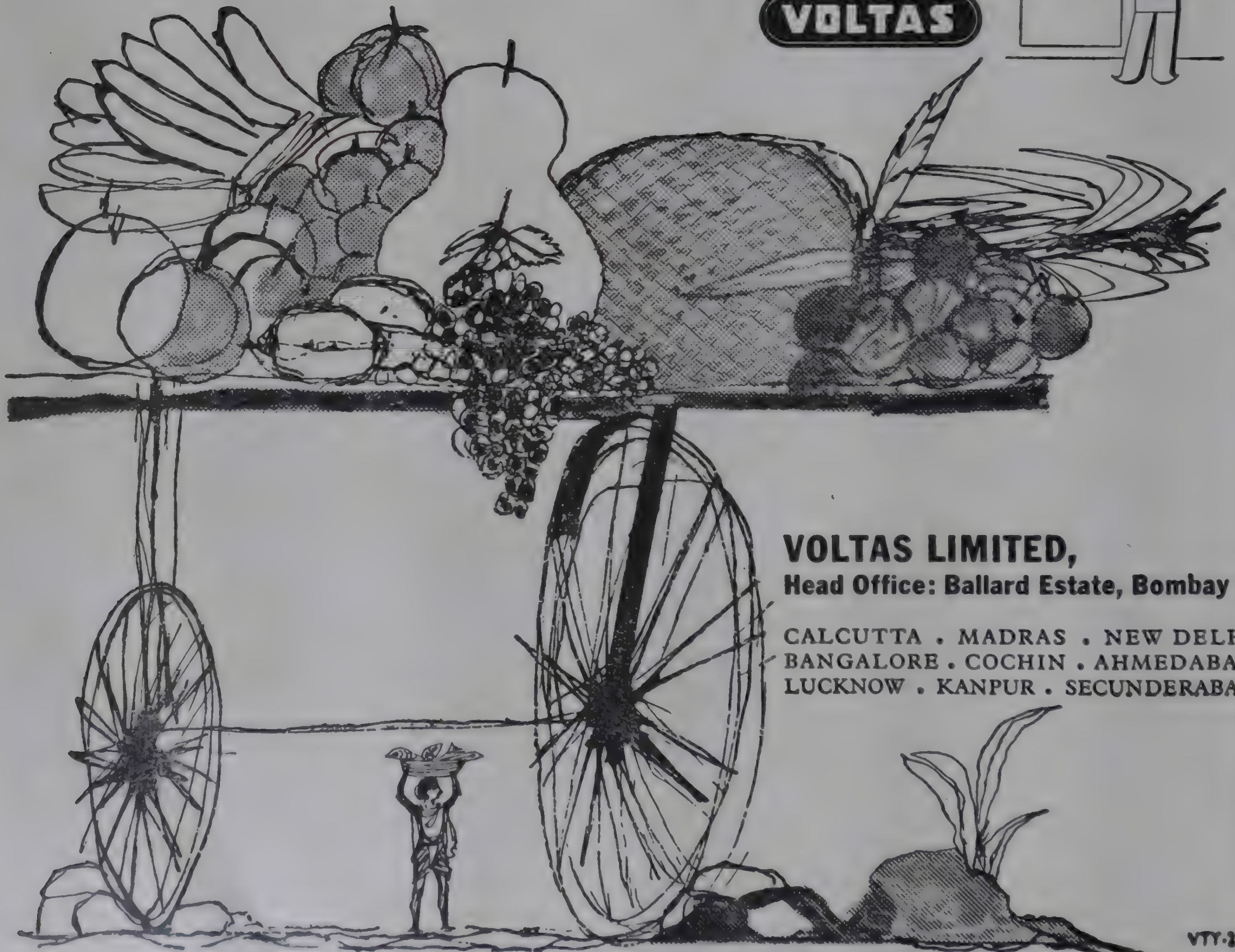

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VTT-26.

CHEMICAL COMPOSITION AND SHELF-LIFE OF FORTIFIED GROUNDNUT FLOUR AND BLENDS OF GROUNDNUT FLOUR WITH SKIM MILK POWDER

By Kantha Joseph, K. Indira, P. K. Tasker, M. Narayana Rao, M. Swaminathan,
R. Rajagopalan, A. Sreenivasan and V. Subrahmanyan

(*Central Food Technological Research Institute, Mysore*)

The diets consumed by the majority of people in India, Africa, Latin America and several other Asian countries are deficient in various nutrients such as proteins, vitamins and minerals.[1,2] The consequences of these dietary deficiencies are strikingly seen in the case of vulnerable groups of the population, *viz.* weaned infants, young children and expectant and nursing mothers.[3] Protein malnutrition (*Kwashiorkor*) is widely prevalent among children belonging to the low income groups of the population[4]. Protective foods like milk, egg, fish, meat etc., are not available in sufficient quantities in the above mentioned countries[5] and consequently there is an urgent need to develop nutritious supplementary foods based on locally available protein rich foods fortified with vitamins and minerals.

The important and abundant sources of proteins available in most of the developing countries are the low-fat oil seed meals such as meals from groundnut, soya, coconut etc., and pulses such as grams, beans etc[5]. During recent years, considerable interest has been evinced in different countries on the utilization of oilseeds and legumes as supplements to the diets for children[6,7]. Groundnut is available in large quantities in India and Africa.[5] A 3:1 blend of groundnut flour and Bengalgram flour fortified with calcium salts and vitamins has been found to be an effective supplement to diets based mainly on cereals[8]. Groundnut flour by itself has been found to supplement diets based on different cereals and tuber flours[9]. The proteins of groundnut are partially lacking in lysine, methionine and threonine and have a biological value lower than that of milk proteins[10], but their nutritive value can be enhanced by blending with small amounts of skim-milk powder.[11] The use of such blends as supplements to the diets of children would help to extend the limited available supplies of skim milk powder. The present paper describes the results of studies on the chemical composition and keeping quality of protein foods based on blends of groundnut flour and skim milk powder.

Experimental

Groundnut flour: Edible quality low-fat groundnut flour was prepared according to Subrahmanyan *et al*[12]. The process in brief consisted of the following steps: (i) light roasting of groundnut kernels freed from foreign matter at about 90-100°C for 5 minutes, (ii) removal of testa using a blanching machine, (iii) separation of shrivelled, spoilt and fungus attacked seeds by hand picking, (iv) pressing the oil in a screw press and (v) powdering the resulting cake in a hammer mill. The product had a light creamy colour, a pleasant nutty odour and acceptable taste.

Skim milk powder: A spray dried skim milk powder of good quality was used.

Blends of groundnut flour and skim milk powder: Two blends of groundnut flour with skim milk powder were prepared by mixing the two ingredients in the ratio of 4:1 and 9:1 respectively.

Groundnut flour and blends of groundnut flour with skim milk powder were fortified with vitamins A and D, thiamine and riboflavin and calcium phosphate and calcium carbonate. The amounts of calcium salts and the different vitamins added were so adjusted that the content of these nutrients in groundnut flour and the blends was nearly the same. The products were flavoured with vanilin.

The chemical composition of the different materials and of skim milk powder, determined according to A.O.A.C. methods[13] is given in Table I.

The materials were packed in sealed containers

TABLE I. *Chemical composition of groundnut flour and blends of groundnut flour with skim milk powder fortified with vitamins and calcium salts*

(Values per 100g)

Constituents	Groundnut flour[1]	9 : 1 blend of groundnut flour and skim milk powder[1]	4 : 1 blend of groundnut flour and skim milk powder[1]	Skim milk powder[2]
Moisture (g) ...	8.8	8.2	7.6	3.8
Protein (N × 6.25) (g)	50.1	48.6	47.2	35.6
Fat (g) ...	9.0	8.2	7.2	0.1
Calcium (g) ...	0.84	0.85	0.85	1.32
Phosphorus (g) ...	0.75	0.71	0.67	1.05
Iron (mg) ...	5.2	4.7	4.3	0.5
Thiamine (mg) ...	1.92	1.86	1.85	0.56
Riboflavin (mg) ...	3.40	3.48	3.52	1.52
Nicotinic acid ...	19.6	17.6	15.7	1.1
Vitamin A (i.u.)[3] ...	3000	3000	3000	3000
„ D (i.u.)[3] ...	300	300	300	300

[1] Fortified with vitamins A and D, thiamine, riboflavin and calcium phosphate and carbonate.

[2] Fortified with vitamins A and D only.

[3] Added values.

(1 lb. cans) and stored at 37°C for a period of 9 months. Control samples were kept at 0°C. Samples stored at 37°C were analysed once in three months for free fatty acids, peroxide value, vitamin A, thiamine and riboflavin. Determinations of free fatty acids and peroxide value were made according to Krishnamurthy *et al*[14]. Vitamin A and thiamine content of the samples were determined according to A.O.A.C. methods.[13] Riboflavin was estimated according to the methods of the Association of Vitamin Chemists[15]. The organoleptic quality of the food was tested by a panel of 8 judges selected from among the Institute staff members. The score system adopted was similar to that of Chandrasekhara *et al*[16]. A product having a score of 2 or less was considered acceptable. The results of storage studies are given in Table II.

Results and Discussion

The chemical composition of groundnut flour and blends of groundnut flour with skim milk powder fortified with vitamins and minerals, as compared to that of skim milk powder is given in Table I. A daily supplement of 40-50 g. of fortified groundnut flour or its blend with skim milk powder will provide about half the daily requirements of proteins, vitamins and minerals for children.

Table II shows that groundnut flour and its blends with skim milk powder keep well for a period of 9 months at 37°C in hermetically sealed containers. The losses of vitamin A, thiamine and riboflavin in the different products during the period were 21-23 per cent, 15-19 per cent and 8-12 per cent respectively.

TABLE II. *Shelf-life of groundnut flour and its blends with skim milk powder fortified with vitamins and minerals*

Constituent	Initial			3 months			6 months			9 months		
	G.F.	9 : 1 blend	4 : 1 blend	G.F.	9 : 1 blend	4 : 1 blend	G.F.	9 : 1 blend	4 : 1 blend	G.F.	9 : 1 blend	4 : 1 blend
Free fatty acids[1] (as % oleic acid)	1.8	1.7	1.5	3.8	3.5	3.1	4.8	4.6	4.5	6.9	6.5	6.4
Peroxide value[2]	nil	nil	nil	3.4	3.2	3.1	6.5	6.2	6.2	8.2	7.6	7.4
Vitamin A (i.u.) ...	2960	2980	2980	2720	2690	2670	2480	2420	2450	2310	2340	2290
Thiamine (mg)	1.92	1.86	1.85	1.85	1.80	1.82	1.78	1.72	1.76	1.65	1.68	1.57
Riboflavin (mg)	3.40	3.48	3.52	3.34	3.29	3.38	3.22	3.15	3.26	3.11	3.06	3.12

G.F. = Groundnut flour with moisture content 8.8%

9 : 1 blend = blend of groundnut flour and skim milk powder; moisture content 8.2%

4 : 1 blend = blend of groundnut flour and skim milk powder; moisture content 7.6%

[1] Expressed on fat basis.

[2] Millimols of thio per g. of fat.

Summary

1. Edible low fat groundnut flour and blends of groundnut flour with skim milk powder (in the ratio of 9:1 and 4:1 respectively) fortified with calcium salts and vitamins A and D, thiamine and riboflavin were prepared.

2. The products kept well at 37°C in hermetically sealed containers for a period of 9 months. The losses of vitamin A, thiamine and riboflavin in the different products during the storage period were 21-23 per cent, 15-19 per cent and 8-12 per cent respectively.

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NUTRITIVE VALUE OF THE PROTEINS OF GROUNDNUT FLOUR AND A 4:1 BLEND OF GROUNDNUT FLOUR AND SKIM MILK POWDER

By P. K. Tasker, A. A. Joseph, H. N. Ananthaswamy, K. Indiramma, M. Narayana Rao
M. Swaminathan, A. Sreenivasan and V. Subrahmanyan

(Central Food Technological Research Institute, Mysore)

Proteins of vegetable origin, in general, are partially lacking in one or more of the essential amino acids. Hence they possess a lower nutritive value than animal proteins[1]. It is now well recognised that proteins from different sources mutually supplement each other and blends of two or more proteins may possess a higher biological value than the individual components.[2] One of the most abundantly available protein rich foods in India and Africa is low fat groundnut flour. The limiting amino acids in groundnut flour are methionine, lysine and threonine[3]. The availability of all the essential amino acids from groundnut protein is uniformly high in the case of albino rats[4]. Groundnut proteins when incorporated at 20 per cent level in the diet have been reported to promote good growth in experimental animals[5]. At a lower level (10 per cent), groundnut proteins have been found to be inferior to milk proteins in promoting growth[6]. In the present investigation, the protein efficiency ratios of the proteins of groundnut flour and a 4:1 blend of groundnut flour and skim milk powder have been determined at 10, 15 and 20 per cent levels of protein intake.

Experimental

Materials: The samples of low fat groundnut flour, skim milk powder and the 4:1 blend of the foods used in this experiment were the same as those described in the preceding paper[7].

The essential amino acid composition of the proteins of groundnut flour and skim milk powder were determined according to the methods used by Krishnamurthy *et al*[8]. The results are given in Table I.

Animal experiments: The protein efficiency ratios (PER) of the proteins at 10, 15, and 20 per cent levels of protein intake were determined by the rat growth method of Osborne, Mendel and Ferry[9]. Weanling albino rats (Wistar strain) weighing 40-45g. from the laboratory stock colony were allotted to the required number of groups according to a randomised block design. The composition of experimental diets is given in Table II.

TABLE I. *Essential amino acids composition of groundnut flour, skim milk powder and a 4:1 blend of groundnut flour and skim milk powder (amino acids g/16g. N.)*

Amino acid	Groundnut flour	4 : 1 blend of groundnut flour and skim milk powder	Skim milk powder	FAO reference protein pattern*
Arginine	11.3	10.2	4.3	...
Histidine	2.1	2.1	2.4	...
Lysine	3.6	4.4	8.5	4.2
Tryptophan	1.0	1.1	1.6	1.4
Phenylalanine ...	5.1	5.2	5.6	2.8
Methionine	1.0	1.4	3.2	2.2
Cystine	1.6	1.5	1.1	...
Total sulphur amino acids	2.6	2.9	4.3	4.2
Threonine	2.7	3.1	4.8	2.8
Leucine	6.9	7.5	11.2	4.8
Iso-leucine	4.6	5.2	7.7	4.2
Valine	4.4	4.8	7.2	4.2

* *FAO Nutrition Studies No. 16,* Food and Agriculture Organization, Rome, 1957.

The diets were cooked with three times the weight of water by steaming for 5 minutes and fed *ad lib* to the rats. The rats were weighed weekly and records of food intake were maintained for each animal. The PER was calculated for each rat and the results were analysed by the analysis of variance technique appropriate for randomised block design. The results are given in Table III.

Results and Discussion

Growth rate: The mean growth rates of rats on diets containing 10 per cent protein from groundnut flour or a 4:1 blend of groundnut flour and skim milk powder were significantly less than that obtained with the diet containing 10 per cent milk protein. At 15 per cent or 20 per cent protein intake, however, there were no significant differences in the growth rates of rats fed on the different diets. The growth rate of rats fed on diets containing 10 per cent milk proteins was significantly less than that of rats on 15 per cent milk protein diet which in turn was, however, not significantly less than that of rats on 20 per cent milk protein diet. Similar

TABLE II. *Percentage composition of experimental diets*

	Protein content 10%			Protein content 15%			Protein content 20%		
	I	II	III	IV	V	VI	VII	VIII	IX
Groundnut flour	20.0	...	...	40.0	...	...	60,0	...	...
4:1 blend of groundnut flour and skim milk powder	...	20.6	...	...	41.2	...	...	61.8	...
Skim milk powder	...	...	28.0	...	...	56.0	...	...	84.0
Salt mixture*	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Vitaminised starch†	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Groundnut oil	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Corn starch	67.0	66.4	59.0	47.0	45.8	51.0	27.0	25.2	3.0

* Hubbel, Mandel and Wakeman salt mixture.

† Vitaminised starch of Chapman *et al*[10].

TABLE III. *Protein efficiency ratio of the proteins of groundnut flour and 4:1 blend of groundnut flour and skim milk powder*

(Experimental period—4 weeks. Mean values for 6 male rats in each group)

Source of protein	Level of protein (%)	Initial body weight (g)	Protein intake (g)	Gain in body wt. (g)		Protein efficiency ratio	
Groundnut flour ..	10	47.0	19.68	36.5	±4.87 (40d.f.)	1.84	±0.106 (40d.f.)
,,	15	47.3	37.46	74.5		1.98	
,,	20	47.2	47.02	84.0		1.78	
4:1 blend of groundnut flour and skim milk powder ...	10	47.2	22.71	53.8		2.36	
,,	15	46.8	35.73	77.7		2.22	
,,	20	47.0	51.36	94.3		1.83	
Skim milk powder	10	46.7	20.93	63.8		3.04	
,,	15	47.2	34.0	78.7		2.32	
,,	20	47.5	44.82	88.3		1.97	
Critical difference at 5%	...		...	11.60		0·253	
,, ,, 1%	...		...	16.69		0.364	
,, ,, 0.1%	...		...	22.79		0.497	

results were obtained with diets containing different levels *i.e.* 10, 15 and 20 per cent protein from groundnut flour or 4:1 blend of groundnut flour and skim milk powder.

Protein efficiency ratio: The PER of proteins of groundnut flour at 10 per cent level of intake was significantly less than that of the proteins of a 4:1 blend of groundnut flour and skim milk powder which in turn was less than that of the milk proteins. On the other hand, at 15 or 20 per cent level of protein intake, no significant difference was observed in the PER of the different proteins.

The results obtained in this study are of considerable interest and importance as they have shown that diets containing 15 or 20 per cent protein from groundnut flour or 4:1 blend of groundnut flour and skim milk powder can promote good growth in albino rats, comparing well with that obtained with the same levels of milk proteins. It is also of interest to note that there were no significant differences in the PER of the proteins of milk and those of 4:1 blend of groundnut flour and skim milk powder at 15 and 20 per cent levels of protein intake. These findings are of considerable importance to regions where milk and other animal proteins are in short supplies. The use of blends of vegetable proteins and skim milk powder will help to extend the available supplies of skim milk powder in these regions.

Summary

1. The protein efficiency ratio of the proteins of groundnut flour, skim milk powder and a 4:1 blend of groundnut flour and skim milk powder were determined at 10, 15 and 20 per cent levels of protein intake.

2. The protein efficiency ratio of the proteins of the 4:1 blend of groundnut flour and skim milk powder at 10 per cent level of intake (2.36) was significantly higher than that of the proteins of groundnut flour (1.98) but lower than that of the milk proteins (3.04).

3. At higher levels of protein intake (15 and 20 per cent), there was no significant difference in the protein efficiency ratio of the proteins of groundnut flour, skim milk powder or a 4:1 blend of groundnut flour and skim milk powder, the PER ranging from 1.98 to 2.32 at 15 per cent level and 1.78 to 1.97 at 20 per cent level.

4. The growth rates of rats on diets containing 15 or 20 per cent protein from groundnut flour or 4:1 blend of groundnut flour and skim milk powder were nearly equal to those obtained on diets containing 15 or 20 per cent milk proteins respectively.

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SUPPLEMENTARY VALUE OF LOW-FAT GROUNDNUT FLOUR, SKIM MILK POWDER AND THEIR BLENDS TO POOR RICE DIET

By P. K. Tasker, M. Narayana Rao, K. Indiramma, M. Swaminathan, A. Sreenivasan and V. Subrahmanyan

(Central Food Technological Research Institute, Mysore)

Rice forms the staple food in the diets of approximately half the world's population. Diet surveys carried out in different rice-eating areas in India have shown that rice supplies 70-80 per cent of the calories in the diets of the people[1]. Rice is also the most important source of proteins, minerals and B-vitamins in such diets.[1] The nutritive value of poor Indian diets based on rice was extensively investigated by Aykroyd and Krishnan[2-5]. Their investigations have shown that typical poor rice diets are deficient in calcium, protein, vitamin A and some of the B-group vitamins especially riboflavin. Aykroyd and Krishnan[4] reported that skim milk powder, which is a rich source of calcium and protein, was highly effective while soyabean and Bengalgram were less effective as supplements to poor rice diet. Kuppuswamy *et al*[6] reported that Indian multipurpose food (3:1 blend of groundnut flour and Bengalgram flour fortified with vitamins and calcium salts) possessed a marked supplementary value to poor Indian rice diets. In the preceding paper, the results on the chemical composition and keeping quality of protein foods based on blends of groundnut flour and skim milk powder have been reported[7]. The present paper relates to studies on the supplementary value of the above foods, as compared to that of skim milk powder, to a poor Indian rice diet.

Experimental

Materials and methods: Low-fat groundnut flour, skim milk powder and their blends used in this study were the same as those described in an earlier paper[7]. The chemical composition of fortified groundnut flour, skim milk powder and their blends have already been reported[7].

Animal experiments: Groups of freshly weaned albino rats weighing about 40 g. (10 in each group, equally divided according to sex and body weight, allotted according to randomized block design ignoring litters) were fed *ad lib* on the different diets the composition of which is given in Table I. The composition of the basal rice diet was the same as that recommended by the Vanaspathi Research Advisory Committee[8]. Sufficient quantities of the different supplements were incorporated by replacing an equal amount of rice in the basal rice diet so as to provide about 5 per cent extra protein in the diet. A separate group of weanling rats in the same weight range was used to determine the initial body composition. Weighed quantities of diets were cooked with three times the amount of water in feeding cups by steaming for 10 minutes and fed to the rats. Food and water were given *ad lib.* The feeding was continued for a period of 8 weeks. Careful records of food intake and weekly increase in body weight of the animals were maintained.

After feeding for 8 weeks, the haemoglobin and red blood cell counts were determined in blood drawn from the tails of the animals according to Joseph *et al*[9]. The animals were anaes-

TABLE I. *Percentage composition of experimental diets**

	Diets				
	I	II	III	IV	V
Rice flour ...	78.5	68.5	68.2	67.9	64.5
Protein food ...	—	10.0[1]	10.3[2]	10.6[3]	14.0[4]

* All the diets contained the following other ingredients
Tur dhal, (*Cajanus cajan*) 5.0; amaranthus leave (*Amaranthus gangeticus*) 2.1; brinjal (*Solanum melongena* 8.2; skim milk powder, 0.9; common salt, 0.3; groundnu oil, 5.0.

[1] Groundnut flour

[2] 9:1 blend of groundnut flour and skim milk powde

[3] 4:1 blend of groundnut flour and skim milk powde

[4] Skim milk powder

thetised with ethyl ether. Blood was drawn by heart puncture and serum separated. The total serum protein content and the electrophoretic pattern of serum proteins were determined according to Tasker *et al*[10]. The liver and carcass were analysed for moisture, protein and fat according to Joseph *et al*[9]. As mentioned earlier, the protein content of the carcasses of a group (5 males) of weanling rats (28 days old) weighing about 40 g. each was determined. From the results, the retention of protein in the different groups of rats over a period of 8 weeks was calculated.

Histological examination of the livers: The histological examination of the livers of female rats was carried out according to Venkata Rao *et al*[11]. In addition, frozen sections were taken from each specimen and stained with Sudan IV in propylene glycol to study the distribution of fat.

Results

Growth rate and composition of blood: Table II gives the average weekly gain in body weight of rats over a period of 8 weeks on the poor rice diet and the same supplemented with fortified low-fat groundnut flour, skim milk powder or their blends. It will be noted that incorporation of the different supplements in the rice diet so as to provide 5.0 per cent extra protein resulted in a highly significant ($P < 0.001$) increase in the growth rate of rats. Skim milk powder promoted a significantly higher growth ($P < 0.01$) than that of groundnut flour or blends of groundnut flour and skim milk powder. Values for total serum protein as well as albumin, alpha$_1$, alpha$_2$, beta and gamma globulin fractions of serum, haemoglobin and red blood cell count are given in Table III. There was no significant

TABLE II. *Gain in body weight of rats on a rice diet supplemented with different protein-rich foods*[1]
(5 males & 5 females in each group) (Duration of experiment-8 weeks)

Supplement to diet[2]	Protein content of diet[3] (%)	Initial body weight (g.)	Daily food intake[3] (g.)	Mean weekly gain in weight (g.)	
None ...	8.04	43.2	7.1	6.94	± 0.64 (32 d.f.)
Groundnut flour ...	13.70	43.7	10.6	14.47	
9:1 blend of groundnut flour and skim milk powder ...	13.65	43.5	10.8	14.65	
4:1 blend of groundnut flour and skim milk powder ...	13.70	43.7	10.6	15.91	
Skim milk powder ...	13.70	43.3	10.9	17.45	

[1] The different protein rich foods supplied approximately 5.0% protein.

[2] Replaced an equal weight of rice in the control rice diet.

[3] Expressed on moisture free basis.

TABLE III. *Composition of blood of rats on a rice diet supplemented with different protein rich foods*

Supplement to diet[1]	Haemoglobin[2]		Red blood cell count[2]		Total serum proteins[3]		Electrophoretic serum protein pattern[3] (% of total serum proteins)									
	%		Millions/mm^3		%		Albumin		Alpha$_1$ globulin		Alpha$_2$ globulin		Beta globulin		Gamma globulin	
None	14.60	± 0.14 (32 d.f.)	6.16	± 0.13 (32. d.f.)	5.28	± 0.06 (16 d.f.)	28.0	± 1.03 (16 d f.)	16.7	± 1.25 (16 d.f.)	12·1	± 0.64 (16 d.f.)	22.1	± 0.97 (16 d.f.)	21.1	± 1.15 (16 d.f.)
Groundnut flour ...	15.25		6.40		6.04		31.0		16.6		9.7		22.8		19.9	
9:1 blend of groundnut flour and skim milk powder	15.22		6.26		6.28		32.5		18.7		10.7		20.6		17.5	
4:1 blend of groundnut flour and skim milk powder	15.15		6.50		6.32		34.7		16.0		10.7		22.1		16.5	
Skim milk powder ...	15.10		6.34		6.46		36.8		16.2		12.1		21.1		13.8	

[1] Replaced an equal weight of rice in the control rice diet.

[2] Average of 5 males and 5 females per group.

[3] Average of 5 males per group.

difference in the R.B.C. count of the blood of rats on the different diets. The haemoglobin and total serum protein of rats on the rice diet were significantly less than those of rats receiving the different supplements. No significant differences, however, were observed in the values for the different blood constituents of rats receiving the different protein supplements.

Composition of liver and carcass: There was no significant difference in the mean fat, moisture and protein contents of the livers of rats on the different diets (Table IV). The xanthine oxidase activity of the livers of rats receiving the rice diet was significantly less than that of rats receiving the different supplements. No significant differences, however, were observed in the xanthine oxidase activity of the rats receiving the different protein supplements. Table V shows the results of analysis of the carcasses of rats fed on the different diets. The mean protein content of the carcasses of the rats fed on the rice diet was significantly lower ($P<0.01$) than those in other groups.

Histological structure of liver: The livers of animals fed on a poor rice diet showed a mild degree of parenchymal damage of the protein deficiency type. No appreciable fatty change or necrosis of the liver cells was observed. The livers of rats receiving the supplements of groundnut flour, skim milk powder or their blends

TABLE IV. *Composition of liver of rats on a rice diet supplemented with different protein rich foods*

Supplement to diet[1]	Fresh weight of liver (g)	Composition of liver[1]						Xanthine oxidase activity[2]	
		Moisture %		Fat %		Protein %		μlO$_2$/gm/hr.	
None	5.1	71.2	± 0.31 (16 d.f.)	4.2	± 0.21 (16 d.f.)	17.1	± 0.22 (16 d.f.)	130.8	± 18.7 (16 d.f.)
Groundnut flour	7.5	70.9		3.4		18.4		391.6	
9 : 1 blend of groundnut flour and skim milk powder	7.3	70.7		3.7		17.9		443.2	
4 : 1 blend of groundnut flour and skim milk powder	7.2	70.4		3.4		18.8		429.6	
Skim milk powder	7.3	70.9		3.0		18.5		457.8	

[1] Replaced an equal weight of rice in the rice diet.

[2] Average of 5 males per group.

TABLE V. *Composition of carcass of rats on a rice diet supplemented with different protein-rich foods*

Supplement to diet[1]	Body weight[2] (g)	Composition of carcass[2]					
		Moisture %		Protein %		Fat%	
None	108.0	63.6	± 0.51 (16 d.f.)	15.5	± 0.31 (16 d.f.)	15.5	± 0.51 (16 d.f.)
Groundnut flour	180.4	56.2		17.8		19.7	
9 : 1 blend of groundnut flour and skim milk powder ...	186.8	56.5		17.7		19.1	
4 : 1 blend of groundnut flour and skim milk powder ...	188.0	54.1		18.2		19.4	
Skim milk powder	205.0	57.0		18.0		19.3	

[1] Replaced an equal weight of rice in the rice diet.

[2] Average of 5 males per group.

were quite normal indicating thereby that addition of 5.0 per cent extra amount of different proteins was effective in correcting the protein deficiency in poor rice diet.

Intake and retention of protein: The intake and retention of protein by the rats fed on the different diets are given in Table VI. No significant difference was observed in the amount of protein retained per 100 g. increase in body weight of rats receiving the different protein supplements. The amount of protein retained per 100 g. increase in body weight on the rice diet was, however, significantly lower than those observed in the groups receiving the different protein supplements.

Discussion

Aykroyd and Krishnan[2,3], found that the primary deficiencies in poor rice diet were calcium and protein. In the present study, skim milk powder which is a rich source of proteins of high biological value and calcium, produced the maximum supplementary value to the diet. Low-fat groundnut flour and its blends with 10-20 per cent of skim milk powder (fortified with calcium and vitamins) also produced a highly significant improvement in the growth promoting value of the diet, even though these supplements proved slightly less effective than skim milk powder in this respect. Low fat groundnut flour containing 10-20 per cent of skim-milk powder produced a slightly better growth response than groundnut flour alone.

The mean xanthine oxidase activity in the liver of rats on rice diet was lower than that of rats receiving the supplements of groundnut flour, skim milk powder or their blends. Williams and Elvehjem[12] observed that the xanthine oxidase activity in the liver was highly sensitive to changes in the quantity and quality of dietary protein. There was no significant difference in the xanthine oxidase activity of the liver of rats receiving the different supplements. The livers of animals fed on the rice diet showed a mild degree of parenchymal damage of the protein deficiency type whereas the livers of animals receiving the different supplements were quite normal. The results show that groundnut flour and its blends with 10-20 per cent skim milk powder are equally effective as skim milk powder in correcting the protein deficiency in poor rice diet, preventing liver damage and maintaining the xanthine oxidase activity of the livers of rats.

Summary

1. Supplementation of rice diet with low fat groundnut flour, skim milk powder or their blends suitably fortified with certain vitamins and minerals so as to provide about 5.0 per cent extra protein in the diet resulted in highly significant increases ($P<0.001$) in the growth rate of rats.

TABLE VI. *Intake and retention of protein by the different groups of rats[1] during 8 weeks on rice diet supplemented with different protein-rich foods*

Supplement to diet[2]	Total protein intake (g)	Total increase in body wt. (g)	Body protein		Protein retained		
			Initial[3] (g)	Final (g)	(g)	g/100g increase in body weight	
None	41.0	64.2	7.71	16.74	9.04	14.07	± 0.42 (16 d.f.)
Groundnut flour	92.1	135.8	7.84	32.10	24.26	17.86	
9:1 Groundnut flour and skim milk powder ...	90.2	143.2	7.67	33.07	25.40	17.74	
9:1 Groundnut flour and skim milk powder ...	89.0	144.0	7.92	34.22	26.30	18.27	
Skim milk powder	89.8	161.2	7.92	36.91	28.99	17.99	

[1] Average of 5 males per group.

[2] Replaced an equal weight of rice in rice diet.

[3] Calculated at 17.6% of the initial weight.

2. The blood of rats receiving the protein supplements had higher haemoglobin and total serum protein contents than that of rats receiving the poor rice diet.

3. The mean xanthine oxidase activity of the liver of rats receiving the protein rich foods were significantly higher than that of rats receiving the poor rice diet. All the protein supplements were equally effective in maintaining the xanthine oxidase activity of the liver at a normal level.

4. The mean protein content of the carcass of rats fed on the rice diet was significantly lower than those receiving the protein supplements.

5. The livers of rats on the control rice diet showed a mild degree of parenchymal damage of the protein deficiency type. On the other hand, the livers of rats receiving supplements of fortified groundnut flour, skim milk powder or their blends were quite normal indicating thereby that low-fat groundnut flour as such or when blended with 10-20 per cent skim milk powder was equally effective as skim milk powder in correcting the protein deficiency in the diets and in preventing liver damage.

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SUPPLEMENTARY VALUE OF GROUNDNUT FLOUR AND BLENDS OF GROUNDNUT FLOUR AND SKIM MILK POWDER TO A MAIZE-TAPIOCA DIET

By P. K. Tasker, A. Paul Jayaraj, M. Narayana Rao, K. Indiramma, M. Swaminathan,
A. Sreenivasan and V. Subrahmanyan

(Central Food Technological Research Institute, Mysore)

Maize (*Zea Mays*) and tapioca (*Manihot utilissima*) are consumed widely as staple foods by the low-income groups of the population in Africa and Latin America[1]. Diets consumed by children of the low-income groups of the population in the above countries consist mainly of maize and tapioca and contain negligible quantities of protective and protein-rich foods such as milk, fish, eggs and meat.[2] Such diets are deficient in proteins, certain minerals and vitamins[3]. Further, the proteins present in the above diets are of low quality[4]. The incidence of protein malnutrition (*Kwashiorkor*) in children is particularly high in regions where such diets are consumed[5]. The problem of improvement of diets based on maize has received considerable attention of research workers and of international agencies like UNICEF, WHO and FAO[6]. The possible use of oilseed meals and legumes which are available in large quantities in these regions as supplements to maize diet has been investigated by some workers[6]. The present paper deals with studies on the supplementary value of groundnut flour and blends of groundnut flour and skim milk powder fortified with vitamins and calcium salts as compared to that of skim milk powder, to a low protein diet based on maize and tapioca.

Experimental

Materials: Whole maize flour used in the investigations was prepared by powdering white maize (local variety) in a flour mill to pass through a 50 mesh sieve. Tapioca flour was prepared from fresh tapioca roots according to Subrahmanyan *et al*[7]. The samples of fortified groundnut flour, skim milk powder and a 4:1 blend of groundnut flour and skim milk powder used in this experiment were the same as those used in the previous investigations[8].

Animal experiments: Freshly weaned albino rats weighing about 40 g. (14 in each group and distributed equally with respect to sex and body weight) were allotted to different groups according to a randomized block design and were housed individually in raised wire screen-bottom cages. They were fed on the different diets, the compositions of which are shown in Table I. Sufficient quantities of different protein foods were incorporated by replacing an equal amount of tapioca flour in the control diet so as to provide 15 per cent extra protein in the diet. A separate group of weanling rats in the same weight range was used to determine the initial body composition. The method of feeding the animals was the same as that described by Tasker *et al*[9]. After feeding for a period of 8 weeks, the haemoglobin and red blood cell count were determined according to Joseph *et al*[10]. Blood was drawn by heart puncture and the electrophoretic pattern of the proteins in the serum separated was determined according to Tasker *et al*[9]. The animals

Table I. *Percentage composition of experimental diets*

Constituents	Maize-tapioca diet (control)	Maize-tapioca diet + groundnut flour	Maize-tapioca diet + 4:1 blend of groundnut flour and skim milk powder	Maize-tapioca diet + skim milk powder
Maize flour	30.0	30.0	30.0	30.0
Tapioca flour ...	60.0	30.1	28.2	17.9
Groundnut flour ...	...	29.9	...	...
Blend of groundnut flour and skim milk powder	...	...	31.8	...
Skim milk powder ...	...	...	...	42.1
Salt mixture[1]... ...	2.0	2.0	2.0	2.0
Vitaminised starch[2] ...	1.0	1.0	1.0	1.0
Groundnut oil[3] ...	6.0	6.0	6.0	6.0
Sodium chloride ...	1.0	1.0	1.0	1.0

[1] Hubbel, Mendel and Wakeman salt mixture.

[2] According to Chapman *et al.*[12]

[3] Contained added vitamins A, D, E and K.

were sacrificed and the livers removed after bleeding the animal. The moisture, fat and nitrogen contents of the livers and carcasses of rats were determined according to the method of Joseph *et al*[10]. The R. N. A. and xanthine oxidase activity of the livers were estimated according to Tasker *et al*[9]. The retention of protein in rats receiving the different diets over a period of 8 weeks was determined by substracting the initial protein content from the final protein content of the carcass of rats according to Shurpalekar *et al*[11]. The results are given in Tables II-VI.

Results

Growth and composition of blood: Incorporation of groundnut flour, skim milk powder and their blends in the maize tapioca diet so as to provide 15 per cent extra protein resulted in a highly significant ($P<0.001$) increase in the growth rate of rats and feed efficiency ratio (Table II). Incorporation of the 4:1 blend of groundnut flour and skim milk powder resulted in a slightly but not significantly higher increases in the growth as compared with those receiving the supplement of groundnut flour. The serum proteins, haemoglobin and red blood cell count of rats (Table III) receiving the supplements of

TABLE II. *Gain in body weight of rats on a maize-tapioca diet supplemented with different protein foods*

(Period of experiment : 8 weeks. Values are means of 7 males & 7 females per group)

Supplement diet[1]	Protein content of diet[2]	Initial body weight	Daily food intake[3]	Mean weekly gain in weight[3]		Feed efficiency ratio[3]	
	%	(g)	(g)	(g)			
None ...	5.08	42.1	7.7	0.63		0.012	
Groundnut flour	19.40	42.2	11.3	17.5	± 0.58 (24 d.f.)	0.22	± 0.001 (24 d. f.)
4:1 blend of groundnut flour and skim milk powder ...	19.40	42.2	11.6	18.6		0.23	
Skim milk powder ...	19.40	42.1	11.5	19.1		0.23	
		C. D. at 5% level		1.68		0.003	

[1] Replaced an equal weight of tapioca in the control maize-tapioca diet (Table I).

[2] Expressed on moisture free basis.

[3] Statistical analysis of the mean weekly gain in weight and feed efficiency ratio was carried out by omitting the control group (maize-tapioca diet) as the values for the group of rats was very low as compared to protein supplemented groups.

TABLE III. *Composition of blood of rats on a maize-tapioca diet supplemented with different protein foods*

Supplement to diet[1]	Haemoglobin[2] (g/100 ml)		Red blood cell count[2] (10^6/cu. mm.)		Serum protein[3] (g/100 ml)		Electrophoretic serum protein pattern									
							% of total serum proteins									
							Albumin		Alpha$_1$ globulin		Alpha$_2$ globulin		Beta globulin		Gamma globulin	
None ...	12.50	± 0.12 (36 d.f.)	4.54	± 0.10 (36 d.f.)	4.50	± 0.07 (18 d.f.)	24.7	± 1.84 (18 d.f.)	19.4	± 0.86 (18 d.f.)	18.8	± 0.54 (18 d.f.)	17.5	± 0.67 (18 d.f.)	19.6	± 1.35 (18 d.f.)
Groundnut flour ...	16.00		6.90		5.99		34.0		19.9		11.4		22.8		11.9	
4:1 blend of groundnut flour and skim milk powder ...	15.90		7.24		6.16		38.1		18.3		7.6		25.1		10.9	
Skim milk powder ...	16.30		7.17		6.26		35.9		19.7		11.7		23.5		9.2	
C.D. at 5% level:	0.35		0.29		0.20		5.47		2.57		1.59		2.00		4.01	
,, 1% ,, :	0.47		0.39		0.27		7.49		3.52		2.18		2.74		5.49	
,, 0.1% ,, :	0.62		0.51		0.37		10.21		4.79		2.98		3.74		7.48	

[1] Replaced an equal weight of tapioca in the control maize-tapioca diet (Table I).

[2] Average of 7 males and 7 females per group.

[3] Average of 7 males per group.

TABLE IV. *Composition of liver of rats on a maize-tapioca diet supplemented with different protein foods*

Supplement to diet¹	Fresh weight of liver² (g)	Moisture (%)		Protein (%)		Composition of liver³					
						Fat (%)		Ribonucleic acid³ mg./g.		Xanthine oxidase activity³ $\mu l O_2$ 10²/g./hr.	
None ...	2.05	72.6	± 5.7 (18 d.f.)	12.8	± 0.33 (18 d.f.)	5.5	± 0.19 (18 d.f.)	28.6	± 0.19 (12 d.f.)	80.6	
Groundnut flour ...	7.87	70.8		18.2		3.8		35.8		380.0	± 21.1 (8 d.f.)
4:1 blend of groundnut flour and skim milk powder ...	7.86	71.3		18.8		3.5		34.9		499.8	
Skim milk powder ...	7.71	70.2		18.9		3.5		39.3		481.2	
Critical difference at 5% level		1.68		0.58		0.97		5.7		68.8	
,, 1% level		2.30		0.79		1.33		8.0		100.1	
,, 0.1% level		3.14		1.07		1.81		11.3		150.4	

[1] Replaced an equal weight of tapioca in the control maize-tapioca diet (Table I).

[2] Average of 7 males per group.

[3] Average of 5 males per group.

[4] Expressed on moisture and fat free basis.

[5] Statistical analysis of the xanthine oxidase activity, was carried out by omitting the control group (maize-tapioca diet) as the values for this group of rats was very low as compared to protein supplemented groups.

groundnut flour, skim milk powder and their blends were significantly higher ($P<0.001$) than those on the control maize-tapioca diet. There was no significant difference in the serum protein pattern of the rats on the different protein supplemented diets. The serum albumin content of rats fed on the control, maize-tapioca diet was lower than that of rats receiving the protein supplements.

Composition of liver and carcass: No significant differences were observed in the mean fat and protein contents of the livers and carcasses of rats receiving the supplements of groundnut flour, skim milk powder or their blends (Table IV and V). The mean fat content of the livers of rats fed on the maize-tapioca diet was significantly higher ($P<0.001$) than those of rats receiving the protein supplements. The mean ribonucleic acid contents and xanthine oxidase activity of the liver of rats receiving the maize-tapioca diet were significantly lower ($P<0.001$) than those of rats receiving the protein supplements. The mean protein content of the carcass of rats fed on the maize-tapioca diet was also significantly lower ($P<0.001$) than those receiving the protein supplements.

TABLE V. *Composition of carcass of rats on a maize-tapioca diet supplemented with different protein foods*
(Values are average of 7 males per group)

Supplement to diet¹	Body weight (g)	Composition of carcass					
		Moisture %		Protein %		Fat %	
None ...	44.0	68.5	± 0.99 (18 d.f.)	15.3	± 0.32 (18 d.f.)	9.8	± 0.29 (18 d.f.)
Groundnut flour ...	215.0	60.4		18.7		16.9	
4:1 blend of groundnut flour and skim milk powder ...	222.6	58.2		19.4		17.2	
Skim milk powder ...	222.3	58.5		20.1		17.0	
Critical difference at 5% level		2.95		0.95		0.87	
1% ,,		4.04		1.31		1.19	
1% ,,		5.51		1.78		1.62	

[1] Replaced an equal amount of tapioca in maize-tapioca diet (Table I).

Histological structure of liver: A moderate degree of parenchymal damage of the protein deficiency type was observed in the livers of rats receiving the maize-tapioca diet. There was a reduction in cytoplasmic protein in the liver

TABLE VI. *Intake and retention of protein by the different groups of rats on a maize-tapioca diet supplemented with different protein foods during 8 weeks*

(Values are averages of 7 males per group)

Supplement to diet[1]	Total protein intake (g)	Total increase in body weight (g)	Body protein		Protein retained		
			Initial(g)	Final (g)	(g)	g/100 g increase in body weight	
None ...	21.9	1.9	7.37	6.72	—	—	
Groundnut flour	122.7	172.7	7.40	40.16	32.76	18.97	±0.35 (12 d.f.)
4:1 blend of groundnut flour and skim milk powder ...	126.0	180.3	7.40	43.21	35.81	19.86	
Skim milk powder ...	124.9	180.0	7.40	44.71	37.31	20.72	

Critical difference at 5% level: 1.09
1% level: 1.52
0.1% level: 2.15

[1] Replaced an equal amount of tapioca in maize-tapioca diet (Table I).

[2] Calculated at 17.5% of the initial weight.

cells, which also showed varying degrees of cytoplasmic vacuolation of the protein deficiency type. Frozen sections stained with Sudan IV showed abundant stainable fat deposited around the periportal areas. Necrosis of the liver cells was absent. The liver sections of rats receiving the protein supplements were quite normal showing thereby that blends of groundnut flour and skim milk powder were as effective as skim milk powder in correcting the deficiencies of protein in the maize-tapioca diet and in preventing liver damage. The microphotographs of sections of livers of rats receiving the different diets are shown in Figures I-V.

Intake and retention of protein: No significant differences were observed in the mean retention of protein per 100g. increase in body weight of rats receiving groundnut flour, skim milk powder or their blend. On the other hand the rats fed on the maize-tapioca diet lost some body proteins.

Discussion

A diet based mainly on a 1:2 blend of maize and tapioca promoted very little growth in rats. Supplementation of the diet with 15 per cent extra protein from groundnut flour, skim milk powder or their blend made up the deficiency of protein in the diet and promoted good growth of rats, there being no significant difference in the growth response obtained with the different protein foods. Feeding the maize-tapioca diet, resulted in a lowering of the ribonucleic acid content and xanthine oxidase activity of the liver and histological changes in the liver. It is of interest to note that groundnut flour and a 4:1 blend of groundnut flour with skim milk powder were equally efficient as skim milk powder in preventing liver damage and in restoring the liver enzymes to normal levels.

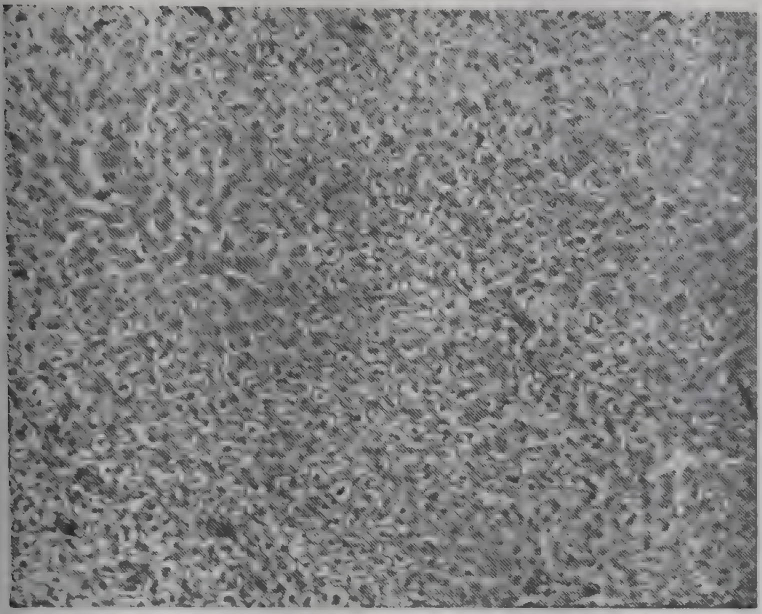
Summary

1. A diet based on a 1:2 blend of maize and tapioca had a low protein content (5.08%) and promoted very little growth (0.63g/wk) in albino rats. Supplementation of the diet with groundnut flour, skim milk powder or their blend so as to provide 15 per cent extra protein in the diet resulted in a highly significant ($P<0.001$) increase in the growth rate of rats (17.5-19.1g/wk). There were no significant differences in the mean weekly growth rates of rats receiving the protein supplements.

2. The serum albumin content of rats receiving the maize-tapioca diet was lower than those of rats receiving the protein supplements.

3. The mean fat content of the livers of rats fed on the maize tapioca diet was significantly ($P>0.001$) higher and the protein content significantly lower ($P>0.001$) than those of rats receiving the protein supplements.

4. There was a moderate degree of parenchymal damage of the protein deficiency type and severe periportal fatty infiltration in the livers of rats receiving the maize-tapioca diet. On the other hand, the livers of animals receiving the protein supplements were quite normal indicating that when providing 15 per cent extra protein, a food based on 4:1 blend of groundnut flour and skim milk powder was as effective as skim milk powder in correcting the protein deficiency in the diet and in preventing liver damage.



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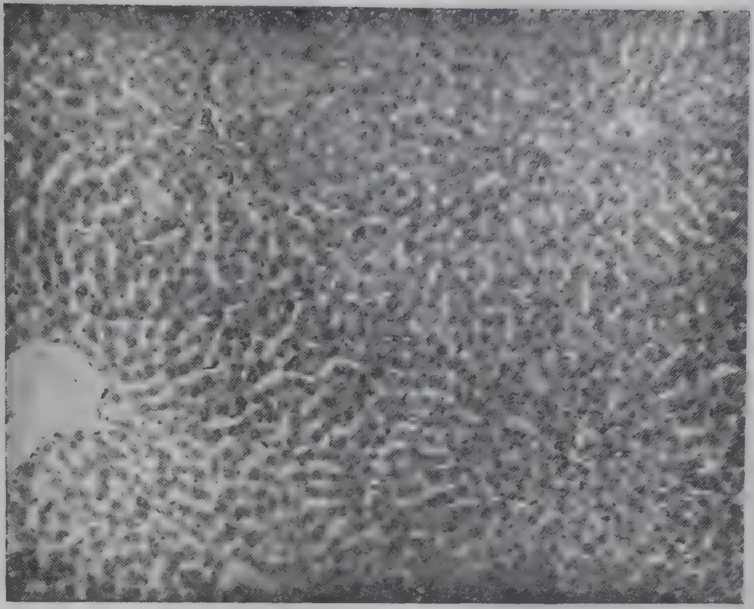

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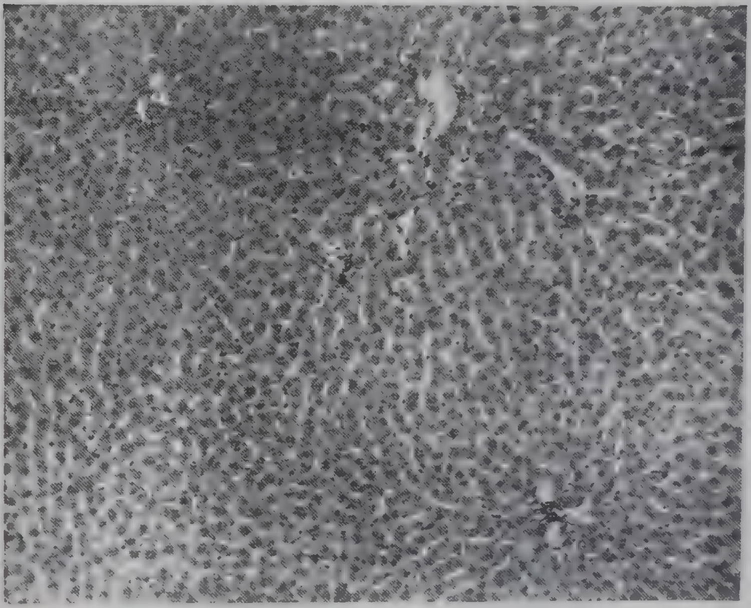
FIG. 1. Liver of rat fed on control maize-tapioca diet. Vacuolation of hepatic cells is prominent in periportal area. Haemotoxylin and eosin × 100.

FIG. 2. Liver of rat fed on control, maize-tapioca diet. Lipid is prominent in hepatic cells around periportal areas. Sudan IV × 100.

FIG. 3. Liver of rat receiving supplements of peanut flour showing normal histological picture. Haemotoxylin and eosin × 100.

FIG. 4. Liver of rat receiving supplements of a 4:1 blend of peanut flour and skim milk powder showing normal histological picture. Haemotoxylin and eosin × 100.

FIG. 5. Liver of rat receiving supplements of skim milk powder showing normal histological picture. Haemotoxylin and eosin × 100.



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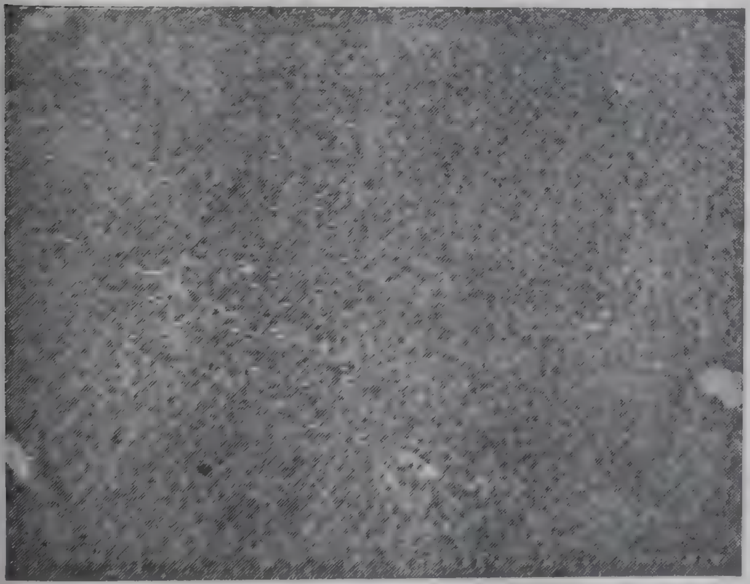

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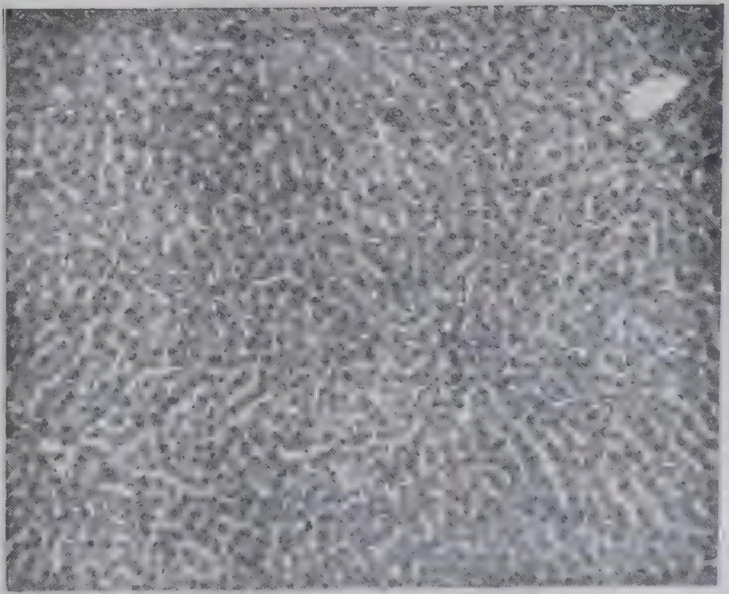

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5. There were no significant differences in the mean retentions of protein (19.86-20.72g) per 100g. increase in body weight of rats receiving skim milk powder or a protein food based on a 4:1 blend of groundnut flour and skim milk powder.

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EFFECT OF SUPPLEMENTARY GROUNDNUT FLOUR FORTIFIED WITH VITAMINS AND MINERALS ON THE GROWTH AND NUTRITIONAL STATUS OF CHILDREN SUBSISTING ON A POOR INDIAN DIET BASED ON RICE

By T. R. Doraiswamy, H. N. Parthasarathy, P. K. Tasker, A. N. Sankaran, R. Rajagopalan, M. Swaminathan, A. Sreenivasan and V. Subrahmanyan

(*Central Food Technological Research Institute, Mysore*)

The diets consumed by children belonging to the low income groups of population in India and other developing countries consist mainly of cereals and tuber flours and lack in protein rich and protective foods like milk, eggs etc[1]. Such diets are deficient in proteins, vitamins and minerals and consequently the rate of growth of children in the above regions is sub-optimal[2]. Protective foods like milk, eggs etc. are not available in adequate amounts. In view of this, the problem of providing alternate sources of supplementary foods based on locally available protein rich foods such as oilseed meals and legumes has received the attention of a number of workers[3-5]. In the preceding papers of this series the results of studies on the preparation and nutritive value of fortified groundnut flour have been reported[6-9]. The present paper deals with studies on the supplementary value of groundnut flour fortified with vitamins and minerals to the diets of school children.

Experimental

Fortified groundnut flour: The groundnut flour fortified with vitamins and minerals used in the present study is the same as that described in an earlier paper of this series. The nutrients provided by a daily supplement of 50 g. of fortified groundnut flour is given in Table I.

Subjects: The studies were carried out in a local boarding home containing about 100 boys ranging in age from 4-16 years. Clinical examinations were made of all the children. Forty six boys aged 5-11 years, free from diseases likely to interfere with the experiment were selected for the study.

TABLE I. *Nutrients in a daily supplement* (50 g.)

Nutrient	Amount
Calories (Cal)	190
Protein (N×6.25) (g)	25.0
Fat (g)	4.5
Carbohydrate (g)	12.3
Calcium (as Ca) (mg)	420.0
Phosphorus (as P) (mg)	375.0
Iron (as Fe) (mg)	2.6
Thiamine (mg)	0.96
Riboflavin (mg)	1.7
Nicotinic acid (mg)	9.8
Vitamin A (i. u.)	1500
Vitamin D (i. u.)	150

Physical measurements and assessment of nutritional status: Measurements of height, weight, haemoglobin content and red-blood cell counts of the blood and assessment of nutritional status were made according to Reddy *et al*[10]. On the basis of initial height, weight and nutritional status, the children were paired and the members of each pair allotted at random to two groups.

Composition of experimental diets and feeding of children: The two groups of children received the boarding home diet which consisted mainly of cereals (rice and wheat) and contained only small quantities of pulses, vegetables and skim milk powder. In addition to the usual diet, the children in the experimental group received daily, a supplement of 50 g. of fortified groundnut flour in the form of chutney along with lunch and dinner. In order to equalise the calorie intake, each child in the control group received a daily supplement of 25g. each of wheat and tapioca flours in the form of savoury pudding served along with lunch and dinner. The pattern of the diets consumed by the children is given in Table II. The nutritive values of the diets consumed were calculated using the figures for the nutritive value of foods given by Aykroyd *et al*[11]. The results together with the dietary requirements suggested by the Nutritional Advisory Committee, Indian Council of Medical Research[12] for children of similar age group are given in Table III. The feeding study lasted for a period of six months, at the end of which height, weight, nutritional status, red blood cell count and haemoglobin content of the blood of the children were determined.

Results

The initial and final values for height, weight, haemoglobin and red blood cell count of the control and experimental children are given in Table IV, and for nutritional status in Table V. For the purpose of statistical analysis, the increases

TABLE II. *Diet consumed by the children in the control and experimental groups*

Food	Intake g/child/day
Basal diet common to both groups	
Rice, raw milled	300.0
Wheat (whole) *atta*	110.0
Pulses (Red gram dhal) (*Cajanus cajan*) Bengal-gram dhal (*Cicer arietinum*) and cow pea (*Vigna catiang*)	21.0
Vegetables, leafy (cabbage)	7.0
Roots and tubers, onion and potato	14.0
Vegetables, non-leafy (brinjal, vegetable marrow, cluster beans, french beans)	67.0
Condiments and spices (red chillies, coriander seeds, cumin, garlic, mustard, tamarind and turmeric)	5.0
Coconut kernel	6.0
Skim-milk powder	14.0
Mutton	7.0
Jaggery	20.0
Common salt	19.0
Groundnut oil	6.0
Supplement	
Control group : wheat flour (*atta*)	25.0
Experimental group :	
Tapioca flour fortified with peanut flour	50.0

The mean consumption unit for both the groups calculated from the international scale of family co-efficients (League of Nations, Health Organization, (1932) was found to be 0·8).

TABLE III. *Mean daily intake of different nutrients by the children*

Nutrients	Control group	Experimental group
Calories (Cal.)	1970	1970
Protein (N×6.25) (g)	48.6	70.4
Fat (g)	14.2	18.6
Carbohydrate	412.0	380.4
Calcium (as Ca) (mg)	465.0	874.0
Phosphorus (as P) (mg)	1028.0	1385.0
Iron (as Fe) (mg)	18.5	18.5
Thiamine (mg)	1.02	1.95
Riboflavin (mg)	0.78	2.46
Nicotinic acid (mg)	11.7	20.3
Ascorbic acid (mg)	22.0	22.0
Vitamin A as carotene (i.u.)	356	356
Vitamin A (i.u.)	2	1502
Vitamin D (i.u.)	—	150

TABLE IV. *Mean values for initial and final measurements of children in the control and experimental groups* (26 boys for each group)

Characters	Control group (*a*)			Experimental group (*b*)			Difference in increase (*b–a*) with	Least significant difference by one tail test		
	Initial	Final	Increase	Initial	Final	Increase	Standard error[1] and results of test significance	5%	1%	0.1%
Height (cm)	120.34	122.17	1.83	120.34	123.14	2.79[2]	0.96 ± 0.13[3]	0.20	0.30	0.43
Weight (kg)	21.96	22.51	0.54	21.97	23.26	1.29	0.75 ± 0.09[3]	0.15	0.21	0.30
Haemoglobin (g/100 ml) ...	11.83	12.39	0.56	11.79	13.18	1.39	0.84 ± 0.13[3]	0.22	0.32	0.45
Red blood cell count (10^6/cu. mm)	4.00	4.13	0.13	3.92	4.36	0.44	0.31 ± 0.05[3]	0.08	0.12	0.16

[1] Based on 25 degrees of freedom. [2] Rounding off error. [3] Highly significant at 0.1%.

TABLE V. *Nutritional status of children in the control and experimental group* (26 boys in each group)

Total nutritional score[1]	Initial nutritional status of children		Changes in the nutritional status					
	Control group (no. of children)	Experimental group (no. of children)	Control group (no. of children)			Experimental group (no. of children)		
			Improved	Stationary	Deteriorated	Improved	Stationary	Deteriorated
0	3	1	...	1	2	...	1	...
1	2	...	...	2	...	...	...	...
2	6	7	1	5	...	6	1	...
3	8	12	...	6	2	10	2	...
4	6	6	2	4	...	4	2	...
5	1	...	...	...	1	...	...	...
Total	26	26	3	18	5	20	6	...

[1] According to the recommendation of the Indian Medical Research Council: Nutritional Advisory Committee (1948).

in the various measurements during the experimental period were obtained for each subject and the mean for each group calculated. The differences in the mean increase between the two groups were tested by the 't' test appropriate for paired comparison. It can be seen from the results (Table IV) that the mean increases in height, weight, haemoglobin level and red blood cell count of blood in the experimental group were higher than those observed in the control group, the differences being highly significant ($P<0.001$). Twenty children in the experimental group improved in their nutritional status as compared with only three children in the control group. Further, five children in the control group deteriorated in their nutritional status, while none in the experimental group showed any deterioration.

Discussion

It will be of interest to compare the results obtained in the present study with those obtained in similar studies carried out earlier with groundnut curds or Indian multipurpose food. Subrahmanyan *et al*[13,14] reported that supplementation of the diets of children with 12 oz. of groundnut curds or 2 oz. of Indian multipurpose food daily brought about a significant improvement in the growth and nutritional status of school children. The improvement in the growth and nutritional status observed in the present study with a 50g. daily supplement of fortified groundnut flour is nearly of the same order as that observed in earlier experiments with a daily supplement of 12 oz. of groundnut curds or 2 oz. of the Indian multipurpose food[13,14]. The results obtained in the present study have clearly demonstrated that groundnut flour fortified with vitamins and minerals could be used as an effective supplement to the diets of children. Such supplements could be used in regions where milk and other protective foods of animal origin are costly and are not available in adequate quantities.

Summary

1. A feeding experiment extending over a period of 6 months was carried out on two groups of boys, aged 5-11 years (26 boys in each group) to assess the value of supplementing their diets with a daily supplement of 50g. of groundnut flour fortified with vitamins and minerals.

2. The children were paired according to initial height and weight and the members of each pair allotted at random to the control and experimental groups. Values for height, weight, red blood cell count and haemoglobin level of blood were determined at the beginning and at end of the experiment, for subjects in the control and experimental groups.

3. There was a significant ($P<0.001$) increase in the height, weight, red blood cell count and haemoglobin level of the subjects receiving the supplement as compared with the control group. Twenty children in the experimental group improved in their nutritional status as compared with only three children in the control group. Further, five children in the control group deteriorated in their nutritional status while none in the experimental group showed any deterioration.

Acknowledgment

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EFFECT OF SUPPLEMENTARY GROUNDNUT FLOUR FORTIFIED WITH VITAMINS AND MINERALS ON THE RETENTION OF NITROGEN, CALCIUM AND PHOSPHORUS IN CHILDREN SUBSISTING ON A RICE DIET

By H. N. Parthasarathi, P. K. Tasker, T. R. Doraiswamy, N. Nataraja, R. Rajagopalan,
M. Swaminathan, A. Sreenivasan and V. Subrahmanyan

(Central Food Technological Research Institute, Mysore)

In an earlier publication from this laboratory, Joseph *et al*[1] reported that undernourished children, subsisting on a poor Indian rice diet maintained on an average, slight positive nitrogen and calcium balances, which were inadequate for promoting optimum growth of the children. Subrahmanyan *et al*[2,3], Joseph *et al*[4] and Tasker *et al*[5] have reported that supplementation of the poor rice diet daily with 2 oz. of Indian multipurpose food or a low-cost protein food (based on blends of groundnut flour, Bengal-gram flour and coconut meal, fortified with vitamins and minerals) brought about significant increases in the growth and nutritional status and also in the retention of nitrogen, calcium and phosphorus in children. In the preceding paper, Doraiswamy *et al*[6] have reported that supplementation of the diet of undernourished children daily with 50 g. of groundnut flour fortified with vitamins and minerals for a period of 6 months brought about a marked improvement in their growth and nutritional status. The present paper describes the results of studies on the effect of the groundnut flour supplement on the metabolism of nitrogen, calcium and phosphorus in children.

Experimental

Subjects: The metabolism studies were carried out, when the feeding experiments with supplements of fortified groundnut flour had been in progress for a period of 3 months, on seven pairs of boys aged 8-10 years, selected from among the subjects of the feeding trial. The age, height and weight of the experimental children at the time of metabolic study are given in Table I. They had been clinically examined and found free from ailments likely to interfere with the experiment.

Table I. *Age, height and weight of the children at the beginning of the metabolic experiment*

Subject : No	Age (years)	Height (cm.)	Weight (kg)
Rice diet (Control)			
1	8	110	21.8
2	8	115	21.6
3	8	115	21.8
4	9	119	22.3
5	10	123	24.1
6	10	124	23.5
7	10	126	22.9
Rice diet+fortified groundnut flour (*Experimental*)			
8	9	113	21.8
9	9	113	21.9
10	9	116	22.2
11	9	118	21.6
12	9	122	22.3
13	10	125	24.0
14	10	127	23.4

Experimental diets and feeding of children: The procedure followed in the metabolic study was similar to that of Tasker *et al*[5]. The composition of the diets consumed by the subjects during the metabolic experiment was the same as that consumed by the subjects during the feeding trial and has been reported in the preceding paper[6]. Complete duplicates of all dishes consumed by each subject were collected daily, dried in an air oven at 80-90°C and analysed for nitrogen, calcium and phosphorus.

Plan of the experiment: The experimental period lasted 7 days. During the first two days, the children were left to get accustomed to the equipment used for the collection of urine and faeces which were collected only during the last 5 days. The methods used for the collection and preservation of urine and faeces were the same as those of Murthy *et al*[7].

Analytical methods: The methods for the estimation of nitrogen, calcium and phosphorus in food, urine and faeces were the same as those described by Murthy *et al*[7]. All the analyses were carried out in duplicate.

Results

The results for nitrogen metabolism are given in Table II; those of calcium and phosphorus metabolism are given in Table III.

TABLE II. *Mean daily intake, excretion and balance of nitrogen of boys on rice and rice-groundut flour diets*

Diet	Intake (g)	Excretion (g)			Apparent digestibily %	Balance (g)
		Uri-nary	Faecal	Total		
Rice diet[1] ...	7.17	3.74	1.85	5.59	74.2	+1.58
Rice-fortified groundnut flour diet[2]	10.63	6.22	1.86	8.08	82.4	+2.56[3]
Difference ...	3.46	2.48	0.01	2.49	8.2 ± 0.60[4]	+0.98 ± 0.40[4]

[1] Calorie intake 1970 Kcal/child/day.

[2] Calorie intake 1970 Kcal/child/day.

[3] Rounding of error.

[4] Standard error based on 6 d.f.

The mean daily intake of calories, protein, calcium and vitamins on the control diet fell short of the recommended allowances suggested by the Indian Council of Medical Research: Nutrition Advisory Committee[8]. Supplementation of the control diet, daily with a 50 g. supplement of fortified groundnut flour made up the deficiencies of protein, calcium and vitamins in the diet.

Nitrogen metabolism: The mean daily intakes of nitrogen by the children on the rice diet and the rice-groundnut flour diet were 7.17 and 10.63 g respectively. The mean daily excretion of nitrogen in urine of children receiving the rice diet (3.74g) was less than that (6.22g) of children receiving the rice-groundnut flour diet. All the subjects on the two diets were on positive nitrogen balance. The apparent digestibility coefficient of the proteins in the rice-groundnut flour diet (82.4) was significantly higher than that of the proteins in the rice diet (74.2). The mean daily retentions of nitrogen on the rice diet and rice-groundnut flour diet were 1.58 g. and 2.56g. respectively, the difference being significant at 5 per cent level.

TABLE III. *Mean daily intake, excretion and balance of calcium and phosphorus of boys on rice and rice-groundnut flour diets*

Diet	Intake	Excretion			Balance
		Uri-nary	Faecal	Total	
Calcium (mg)					
Rice diet[1] ...	399.4	53.7	229.3	283.0	116.4
Rice-fortified groundnut flour diet[2] ...	801.6	50.8	435.4	486.2	315.3[4]
Difference ...	402.2	−2.9	206.1	203.2	198.8 ± 21.2[5]
Phosphorus (mg)					
Rice diet[1] ...	965.7	317.0	460.9	777.9	187.8
Rice-fortified groundnut flour diet[2] ...	1362.0	348.8	562.3	911.1	450.9
Difference ...	396.3	31.8	101.4	133.2	263.1 ± 31.8[2]

[1] Calorie intake 1970 Kcal/child/day.

[2] Calorie intake 1970 Kcal/child/day.

[3] Rounding of error.

[4] Standard error based on 6 d.f.

Calcium metabolism: All the children on the two diets were on positive calcium balance. The mean daily calcium intakes on the rice diet and rice-groundnut flour diets were 399 and 802 mg. respectively. The mean daily calcium retentions were 116 and 315 mg. respectively, the difference being significant at 0.1 per cent level.

Phosphorus balance: The mean daily intakes of phosphorus on the rice diet and rice-groundnut flour diet were 966 and 1362 mg. respectively. The mean daily phosphorus retention on the rice-groundnut flour diet (451mg) was significantly higher than that observed on rice diet (188mg.), the difference being significant at 0.1 per cent level. All the subjects in the two groups were in positive phosphorus balance.

Discussion

The results obtained in the present investigation show that supplementation of a poor Indian rice diet with 50g. of groundnut flour fortified with vitamins and minerals made up the deficiencies in the diet and brought about significant increases in the retention of nitrogen, calcium and phosphorus in children. Consumption of extra protein resulted in a significant increase in the retention of nitrogen, in spite of inadequate calorie intake (1970 Kcal/day). The results are in conformity with the earlier observations of Joseph *et al*[4]. The results obtained in the present and preceding papers[6] have demonstrated the possibilities of using edible groundnut flour fortified adequately with vitamins and calcium salts as an effective supplement to the poor dietary of the vulnerable groups of the population in regions where protective foods like milk, eggs, meat etc., are not available in adequate amounts.

Summary

1. The metabolism of nitrogen, calcium and phosphorus was studied in seven pairs of boys aged 8-10 years similar in height and weight and fed on a diet based on rice or on the same diet supplemented daily with 50g. of edible groundnut flour fortified with vitamins and minerals.

2. The mean daily nitrogen intakes on the control rice diet and experimental rice-groundnut flour diets were 7.17 and 10.63g. respectively. The apparent digestibility coefficients in the above diets were 74.2 and 82.4 respectively. The mean daily nitrogen retention on rice-groundnut flour diets (2.56g) was significantly higher ($P<0.05$) than that on the rice diet (1.58g).

3. The mean daily intakes of calcium on the rice diet and rice-groundnut flour diets were 399 and 802 mg. respectively. The mean daily calcium retentions were 116 and 315 mg. respectively, the difference being significant at 0.1 per cent level. All the children on the two diets were on positive calcium balance.

4. The mean daily intakes of phosphorus on the rice diet and rice-groundnut flour diets were 966 and 1362 mg. respectively. All the children on the two diets were on positive phosphorus balance. The daily retention of phosphorus on the rice-groundnut flour diet (451mg) was significantly higher ($P<0.001$) than that observed on the rice diet (188mg).

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EFFECT OF SUPPLEMENTARY PROTEIN FOODS BASED ON A BLEND OF GROUNDNUT FLOUR AND SKIM MILK POWDER FORTIFIED WITH VITAMINS AND MINERALS ON THE GROWTH AND NUTRITIONAL STATUS OF UNDER-NOURISHED WEANED CHILDREN

By T. R. Doraiswamy, P. K. Tasker, R. Rajagopalan, A. N. Sankaran, M. Swaminathan, A. Sreenivasan and V. Subrahmanyan

(Central Food Technological Research Institute, Mysore)

The diets of weaned infants and young children, especially of the low income groups of the population in India are grossly deficient in proteins, certain vitamins and minerals[1]. The weaning period is the most critical in the growth of the child since this is the period when the growth of the child is quite rapid and the needs for the different nutrients are also high. But, due to the scarcity and high cost of milk and other protective foods, children of poorer classes after weaning are generally fed on cooked cereals or cereal gruels which are low in protein and at the same time deficient in certain essential vitamins and minerals[2]. Hence, the incidence of protein malnutrition and other deficiency diseases is high among the weaned children of the poorer sections of the people[1].

The problems of providing nutritious supplementary foods based on protein-rich vegetable foods available in the region and fortified with essential vitamins and minerals, have been investigated by several workers[3-7]. Blends of oilseed meals and legumes, along with small amounts of skim milk powder have been shown by different workers as effective supplements to the diets of weaned children.[3-7] In the preceding papers, the results of the studies with albino rats on the supplementary value of a protein food based on a 4:1 blend of groundnut flour and skim milk powder and fortified with vitamins and minerals to poor diets consisting of rice or blends of maize and tapioca have been presented[8,9]. The present paper describes the results of studies on the supplementary value of the food to the diets of undernourished post-weaned children.

Experimental

Protein food based on 4:1 blend of groundnut flour and skim milk powder: The protein food based on a 4:1 blend of groundnut flour and skim milk powder and fortified with vitamins and minerals used in the present study is the same as that described in a preceding paper[10]. The nutrients supplied by a daily supplement of 40g. of the protein food are given in Table I.

Table I. *Nutrients supplied by 40 grams of supplement based on a 4:1 blend of groundnut flour and skim milk powder*

Calories (Kcal) ...	152.0
Protein (N×6.25) (g) ...	18.8
Fat (g) ...	2.9
Carbohydrate (g) ...	12.7
Calcium (mg) ...	340
Phosphorus (mg) ...	268
Iron (mg) ...	1.7
Vitamin A (i.u.) ...	1200
Vitamin D (i.u.) ...	120
Thiamine (mg) ...	0.74
Riboflavin (mg) ...	1.41
Nicotinic acid (mg) ...	6.3

Subjects: The subjects of this study were 92 weaned children between the age group 15-30 months belonging to the low income groups of the population. The initial height, weight, haemoglobin content of blood and nutritional status of the children were determined according to Subrahmanyan *et al*[11]. On the basis of the initial measurements, the children were paired and the members of each pair allotted at random to two groups so that each group consisted of 23 boys and 23 girls.

Composition of experimental diets and feeding of children: A diet survey was conducted at the beginning of the study to determine the composition of diets consumed by the children. The pattern of the diets consumed by the different children was more or less similar and is given in Table II. The diets consisted mainly of rice

TABLE II. *Pattern of the diet consumed by the weaned children*

Food stuffs	Intake (g/child/day) Boys	Intake (g/child/day) Girls
Basal diet		
Rice, raw milled	115	110
Ragi flour	14	12
Wheat flour	14	14
Red gram dhal (*Cajanus cajan*)	10	9
Leafy vegetables: amaranthus tender, columbo keera	6	8
Non-leafy vegetables: brinjals, radish	9	10
Cow's milk	113	115
Jaggery	25	23
Oil	10	9
Salt	4	5
Control group: supplement		
Rice	40	40
Sugar	20	20
Experimental group: supplement:		
Groundnut flour	32	32
Skim milk powder	8	8
Sugar	20	20

and contained small amounts of *ragi* (*Eleusine coracana*), bread, pulses and milk, and were found to be deficient in protein, calcium, vitamin A and riboflavin. In addition to the diet, each child in the experimental group received a daily supplement of 40g. of fortified protein food and 20 g. of powdered sugar while each child in the control group received a daily supplement of 40g. of rice and 20g. of powdered sugar. The supplements were given in the form of porridge sweetened with sugar. The procedure followed for the feeding of the supplements was similar to that of Subrahmanyan *et al*[11]. All the children relished the supplements and none complained of any digestive trouble as a result of consuming the supplement. The nutritive value of the diets consumed by the control and experimental children was calculated using the figures of Aykroyd *et al*[12]. The results together with the optimum dietary requirements suggested by the Indian Council of Medical Research: Nutrition Advisory Committee[13], for children of similar age group are given in Table III. The feeding study lasted for a period of three months at the end of which, height, weight, haemoglobin levels of blood and nutritional status of the children were again determined.

TABLE III. *Mean daily intake of different nutrients by the children compared with standard recommended allowances*

Nutrients	Boys		Girls		Optimum requirement
	Control group	Experi- mental group	Control group	Experi- mental group	
Calories ...	1025	1037	980	995	900*
Protein (N × 6.25) (g)	19.8	38.7	19.3	38.2	26.3*
Fat (g) ...	15.4	18.3	14.4	17.3	—
Carbohydrate (g) ...	205.0	179.5	197.3	171.5	—
Calcium as Ca (mg) ..	300.0	636.0	299.0	635.0	1.0*
Phosphorus as P (mg)	404.0	632.0	396.0	624.0	—
Iron as Fe (mg) ...	8.6	10.3	8.8	10.5	7.0†
Vitamin A (i.u.) ...	200	1400	200	1400	2000
,, as Carotene (i.u.)	316	316	325	325	—
Thiamine (mg) ...	0.38	0.88	0.38	0.88	0.7†
Riboflavin (mg) ...	0.43	1.52	0.43	1.52	1.0†
Nicotinic acid (mg)	3.20	9.0	3.2	9.0	8.0†
Ascorbic acid (mg) ...	7.0	7.0	10.0	10.0	35.0
Vitamin D (i.u.) ...	—	120	—	120	400

* Recommendations of the Indian Council of Medical Research: Nutrition Advisory Committee (1944).

† Recommendation of the (USA) National Research Council: Food and Nutrition Board (1948).

Results

The initial and final values for the height, weight and haemoglobin level of blood of the control and experimental children are given in Table IV and for nutritional status in Table V. It will be seen that at the beginning of the study, the control and experimental children were closely similar. For the purpose of the statistical analysis, the increases in the various measurements during the experimental period were obtained for each subject and the mean for each group calculated. The difference in the mean increase between any two groups was tested by the 't' test appropriate for paired comparison. It can be seen from the results, that the mean increases in height, weight and haemoglobin level in the blood of experimental children were significantly ($P<0.001$) higher than those observed in the control group. Seventeen girls and eighteen boys improved in their nutritional status as compared with three girls and five boys in the control group. Further, five girls and five boys in the control group deteriorated in their nutritional status, while none in the experimental group showed any deterioration.

TABLE IV. *Mean values for initial and final measurements of the children in the control and experimental groups*

Characters	Control group (*a*)			Experimental group (*b*)			Result of the statistical analysis	
	Initial	Final	Increase	Initial	Final	Increase	Difference in the increase (*b-a*) with standard error	Results of test of significance
Girls								
Height (cm) ...	76.49	77.19	0.70	76.5	77.7	1.20	0.50 ± 0.10	Sig. at 0.1%
Weight (kg) ...	8.23	8.55	0.32	8.30	9.28	0.98	0.66 ± 0.05	„ 0.1%
Haemoglobin (g/100ml) ...	10.18	10.50	0.32	10.31	11.37	1.06	0.74 ± 0.14	„ 0.2%
Boys								
Height (cm) ...	78.71	79.53	0.82	78.55	79.95	1.40	0.53 ± 0.12	„ 0.1%
Weight (kg) ...	9.11	9.45	0.34	9.21	10.23	1.02	0.63 ± 0.04	„ 0.1%
Haemoglobin (g/100ml) ...	10.41	10.76	0.35	10.48	11.29	0.81	0.46 ± 0.16	„ 1%

TABLE V. *Nutritional status*[1] *of children in the control and experimental groups*
(23 boys and 23 girls in each group)

Subjects	Changes in nutritional status of children		
	Improved	Stationery	Deteriorated
Girls			
Control group (Rice diet) ...	3	15	5
Experimental group (Rice diet + Protein blend)	17	6	...
Boys			
Control group (Rice diet) ...	5	13	5
Experimental group (Rice diet + Protein blend)	18	5	...

[1] Assessed according to the score card suggested by the Indian Council of Medical Research: Nutrition Advisory Committee (1948).

Discussion

It will be of interest to compare the results obtained in the present study with those obtained in similar studies carried out earlier with other protein supplements. Subrahmanyan *et al*[11]. reported that supplementation of the diets of children daily with 2 oz. of balanced malt food or 3:1:1 blend of groundnut flour, Bengalgram flour and skim milk powder brought about significant improvement in the growth and nutritional status of weaned children. Ganapathi *et al*[14]. reported that supplementation of the diets of weaned infants and pre-school children with a 3:1 blend of groundnut flour and Bengalgram flour or 4:1 blend of Bengalgram flour and skimmed powder brought about increases in the growth rate of the same order as that produced by an equivalent amount of skim milk powder.

It may be concluded from the results obtained in the present and past studies that supplementary foods based on groundnut flour, Bengalgram flour and skim milk powder could be used as supplements to the diets of weaned infants and young children in countries where milk and other protective foods of animal origin are costly and not available in adequate amounts.

Summary

1. A feeding experiment extending over a period of three months was conducted with ninety two weaned infants ranging in age from 15 to 30 months to assess the value of supplementing their diets daily with 40g. of a 4:1 blend of groundnut flour and skim milk powder fortified with vitamins and minerals.

2. On the basis of initial height and weight, the infants were allotted to two groups so that each group consisted of twenty three girls and

twenty three boys. Values for the weight, height, haemoglobin level of blood and nutritional status were obtained at the beginning and at end of the experimental period for the control and experimental groups of children.

3. There was a significant ($P<0.001$) increase in the height, weight and haemoglobin level of blood of children receiving the supplement as compared with the control group. Seventeen girls and eighteen boys improved in their nutritional status as compared with three girls and five boys in the control group. Further, five girls and five boys in the control group deteriorated in their nutritional status, while none in the experimental group showed any deterioration.

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PREPARATION, CHEMICAL COMPOSITION AND SHELF-LIFE OF HIGH PROTEIN FOOD BASED ON GROUNDNUT PROTEIN ISOLATE

By V. Subrahmanyan, Kantha Joseph, Myna Panemangalore, N. Subramanian, R. Rajagopalan, D. S. Bhatia, A. Sreenivasan and M. Swaminathan

(Central Food Technological Research Institute, Mysore)

The diets consumed by weaned infants and young children belonging to the low income groups of the population in several countries in the tropical and subtropical regions consist predominantly of cereals, roots and tubers and contain negligible amounts of protective and protein-rich foods such as milk, eggs, meat and fish[1]. Such diets are deficient in proteins, certain vitamins and minerals and the incidence of protein malnutrition is high particularly among young children[1,2]. Considerable progress has been made during the last 5 years in the development of processed foods based on protein-rich materials of vegetable origin such as oilseed meals and legumes suitable for supplementing the diets of children[3,6]. Recent investigations have shown that groundnut protein isolate could be used for the preparation of infant foods and also for protein foods suitable for treatment of protein malnutrition in children[7-9]. The present paper deals with studies on the preparation and shelf-life of a high protein food based on groundnut protein isolate fortified with essential minerals and vitamins.

Experimental

Groundnut protein isolate: Prepared from screw pressed groundnut meal according to Anantharaman *et al*,[10] the groundnut protein isolate was powdered in a hammer mill (40 mesh) and lightly roasted at 110°C for 3 minutes to develop a pleasant aroma.

Bengalgram flour: This was prepared according to Subrahmanyan *et al*[11].

Seasoning premix: Coriander seeds (60 parts), black pepper (30 parts), turmeric (9 parts) and asafoetida (1 part) were mixed together, slightly roasted with a small quantity of hydrogenated fat and then powdered.

Forms of protein food: The protein food was prepared in two forms: *unseasoned* and *seasoned*. The *unseasoned* product consisted of a blend of groundnut protein isolate (85 parts) and roasted Bengalgram flour (15 parts) fortified with vitamins A, D, thiamine, riboflavin, niacin, pyridoxine, pantothenic acid, folic acid, vitamin B_{12} and choline and essential mineral salts. It was flavoured with vanillin. The *seasoned* product was prepared by adding the above seasoning premix at 3 per cent level and common salt at 3 per cent level to the unseasoned product prepared as above but without the addition of vanillin.

Chemical composition: The chemical composition of the high protein food, determined according to A.O.A.C. methods[12], is given in Table I, along with those of Indian multipurpose food and skim milk powder for comparison.

Packing and storage: The protein food was packed in polythene bags which were sealed in

Table I. *Chemical composition of high protein food as compared to Indian multipurpose food and skim-milk powder*
(Values per 100 g.)

Constituent	High protein* food	Indian multi-purpose food	Skim-milk powder
Moisture (g)	3.1	6.8	4.1
Protein (N × 6.25) (g)	78.3	41.9	35.0
Fat (g)	1.5	8.5	1.0
Ash (g)	7.3	7.0	6.8
Carbohydrate (by diff) (g)	9.8	35.8	53.1
Calcium (g)	1.37	0.67	1.30
Phosphorus (g)	0.75	0.82	1.03
Iron (mg)	6.3	5.1	0.6
Thiamine (mg)	3.0	1.5	0.35
Nicotinic acid (mg)	28.0	14.0	11.0
Riboflavin (mg)	6.0	3.0	1.39
Vitamin A (I.U.)	6000	3000	—
Vitamin D (I.U.)	600	300	—
Calorific value	366	387	361

* Contains in addition added pantothenic acid 7.6 mg. pyridoxine 0.75 mg. choline 1.75 mg. folic acid 0.3 mg. and vitamin B_{12} 3μg.

cans and stored at 37°C for a period of 6 months. Control samples were kept at 0°C. Samples stored at 37°C were analysed, once in two months, for free fatty acids, peroxide value, vitamin A and thiamine. Determinations of free fatty acids and peroxide value were made according to Krishna Murthy *et al*[13]. Vitamin A and thiamine contents of the samples were determined according to A.O.A.C. methods[12]. The organoleptic quality of the protein food was tested by a panel of 6 judges selected from among the Institute staff members. The score system adopted was similar to that of Chandrasekhara *et al*[14]. A product having a score of 2 or less was considered acceptable. The results are given in Table II.

Results and Discussion

The results in Table I show that the high protein food contains almost twice as much protein, calcium and the different vitamins as Indian multipurpose food (a 3:1 blend of groundnut flour and Bengalgram flour fortified with vitamins and minerals) or skim milk powder. As the food represents a highly concentrated source of the different nutrients, smaller quantities of the food can be used for supplementing the diet. This is advantageous in the case of young children as it is often difficult to make them consume large quantities of food. The results presented in Table II show that the high protein food keeps satisfactorily for a period of 6 months at 37°C when stored in hermetically sealed containers. The losses of vitamin A and thiamine during the period were about 20 per cent and 15 per cent respectively.

Summary

1. A process for the preparation of a high protein food based on a 85:15 blend of groundnut protein isolate and Bengalgram flour and fortified with essential vitamins and minerals has been standardized.

2. The protein food can be made in two forms (*i*) *seasoned*, for use in soups and savoury preparations and (*ii*) *unseasoned*, for use in porridge, puddings and sweet preparations. This protein food contains nearly twice as much protein, calcium and vitamins as Indian multipurpose food. Twentyfive grams of the protein food supply about half the daily requirements of protein, calcium and vitamins for young children.

3. Both the seasoned and unseasoned products kept well at 37°C in sealed containers for a period of 6 months. The loss of vitamin A and thiamine during the period was 20 per cent and 15 per cent respectively.

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TABLE II. *Shelf-life of seasoned and unseasoned protein food* based on a 85: 15 blend of groundnut protein isolate and Bengalgram flour stored in hermetically sealed containers at 37°C*

Constituent	Initial		2 months		4 months		6 months	
	S	US	S	US	S	US	S	US
Free fatty acids† (as per cent oleic acid)	2.2	2.1	3.5	3.8	4.6	4.7	5.6	5.8
Peroxide value†, ‡	1.3	1.6	3.9	4.5	5.6	6.3	6.8	8.2
Vitamin A (i.u.)	6,000	6,000	5,740	5,610	5,360	5,240	4,820	4,740
Thiamine (mg)	3.10	3.15	2.92	3.01	2.76	2.81	2.64	2.68

* Initial moisture content of the seasoned (S) and unseasoned (US) samples were 6.4 and 6.6 per cent respectively.

† Expressed on the basis of fat present in the food.

‡ Millimols of thio-per g of fat.

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NUTRITIVE VALUE OF THE PROTEINS OF A HIGH PROTEIN FOOD BASED ON A BLEND OF GROUNDNUT PROTEIN ISOLATE AND BENGALGRAM FLOUR

By Myna Panemangalore, Kantha Joseph, M. Narayana Rao, N. Subramanian, K. Indiramma, D. S. Bhatia, M. Swaminathan, A. Sreenivasan and V. Subrahmanyan

(Central Food Technological Research Institute, Mysore)

In a preceding paper, the results of studies on the preparation and shelf-life of a high protein food based on groundnut protein isolate and Bengalgram flour were reported[1]. The product contained about twice as much proteins as the Indian multipurpose food which is based on a 3:1 blend of groundnut flour and Bengalgram flour developed by Subrahmanyan *et al*[2]. The present paper deals with studies on the protein efficiency ratio of the proteins of high protein food as compared with that of milk proteins.

Experimental

Materials: The sample of high protein food used in this experiment was the same as that described in the earlier study[1]. An imported sample of skim milk powder of good quality was used.

The essential amino acid composition of the proteins of high protein food and skim milk powder determined according to Krishna Murthy *et al*[3] is given in Table I.

Animal experiments: The protein efficiency ratio (PER) of the proteins at 10, 15 and 20 per cent levels of protein intake were determined by the rat growth method of Osborne,

TABLE I. *Essential amino acid composition of high protein food and skim milk powder*

(amino acids g./16 g. N)

Amino acid	High protein food	Skim milk powder	FAO reference protein pattern*
Arginine	11.1	4.3	—
Histidine	2.1	2.4	—
Lysine	3.8	8.5	4.2
Tryptophan	1.0	1.6	1.4
Phenylalanine	5.1	5.6	2.8
Methionine	1.0	3.2	2.2
Cystine	1.6	1.1	—
Total sulphur amino acids	2.6	4.3	4.2
Threonine	2.7	4.8	2.8
Leucine	6.9	11.2	4.8
Isoleucine	4.7	7.7	4.2
Valine	4.4	7.2	4.2

* *Nutrition studies no.* 16, Food and Agriculture Organization, Rome.

Mendel and Ferry[4]. Male, weanling albino rats weighing about 40-45 g. from the laboratory stock colony were allotted to the required number of groups according to randomised block design. They were fed on the experimental diets (Table II) for a period of 4 weeks. The diets were cooked with water by steaming for 5 minutes and fed *ad lib.* Careful records of food intake were maintained for all the groups and the rats were weighed weekly. The protein efficiency ratio was calculated for each rat and the results obtained were statistically analysed.

TABLE II. *Percentage composition of experimental diets*

Constituent	Protein content 10%		Protein content 15%		Protein content 20%	
	I	II	III	IV	V	VI
High protein food	12.8	—	19.2	—	25.6	—
Skim milk powder	—	28.6	—	42.9	—	57.2
Salt mixture*	2.0	2.0	2.0	2.0	2.0	2.0
Vitaminised starch†	1.0	1.0	1.0	1.0	1.0	1.0
Groundnut oil	10.0	10.0	10.0	10.0	10.0	10.0
Corn Starch	74.2	58.4	67.8	44.1	61.4	29.8

* Hubbel, Mendel and Wakeman salt mixture.

† Vitaminised starch of Chapman *et al.*[5]

Results and Discussion

The results are given in Table III.

Growth of rats: The mean increase in weight of rats (35.6 g.) on diets containing 10 per cent protein from high protein food was significantly less than that (73.2 g.) of rats receiving diets containing 15 per cent protein which in turn, however, was not significantly less than that (83.1 g.) of rats receiving diets containing 20 per cent protein. The growth rate of rats on 20 per cent protein from high protein food was nearly of the same order as that observed on 15 per cent milk proteins.

Protein efficiency ratio: The PER of the proteins of high protein food at 10 per cent level of intake was significantly less than that of skim milk powder at the same level of protein intake. On the other hand, at 20 per cent level of protein intake, the PER of proteins of high protein food (1.89) was nearly the same as that of milk proteins (2.04), the differences being not significant.

TABLE III. *Protein efficiency ratio of the proteins of high protein food and skim milk powder*

(Experimental period—4 weeks: values are mean for 8 rats in each group)

Source of protein	Level of protein %	Initial body weight g.	Protein intake g.	Gain in body weight g.		Protein efficiency ratio	
High protein food ...	10	45.2	18.61	35.6	± 3.9 (35 d.f.)	1.92	± 0.065 (35 d.f.)
,,	15	44.9	34.67	73.2		2.11	
,,	20	45.2	43.92	83.1		1.89	
Skim milk powder ...	10	45.1	22.58	69.5		3.09	
,,	15	45.1	35.64	94.5		2.65	
,,	20	45.2	47.16	96.2		2.03	
Critical difference at 5% level				11.3		0.19	
,, 1% level				15.1		0.25	
,, 0.1% level				20.0		0.33	

The results obtained in the present study have shown that diets containing 20 per cent protein from high protein food based on groundnut protein isolate can promote good growth in rats. The PER of the proteins at this level (20 per cent) of intake compares favourably with that of milk proteins at the same level of protein intake. It has also been demonstrated that a protein food based on groundnut protein isolate can meet the protein requirements of albino rats when fed at 20 per cent level of protein intake. The findings are of considerable importance to regions where protein-rich foods, such as milk and other animal foods are in short supplies. In these regions, protein supplements such as the 'high protein food' based on groundnut protein isolate could be used for making up the protein deficiency in the diets.

Summary

At 10 and 15 per cent levels of protein intakes, the protein efficiency ratios of the protein food based on a blend of 85 parts of groundnut protein isolate and 15 parts of Bengalgram flour (*Cicer arietinum*) were significantly less than that of milk

proteins. On the other hand at 20 per cent level of protein intake, the PER of the high protein food (1.89) was nearly the same as that (2.03) of milk proteins, the differences being not significant.

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SUPPLEMENTARY VALUE OF HIGH PROTEIN FOOD BASED ON GROUNDNUT PROTEIN ISOLATE TO A POOR RICE DIET

By Myna Panemangalore, Kantha Joseph, R. Rajagopalan, A. N. Sankaran, N. Subramanian, D. S. Bhatia, M. Swaminathan, A. Sreenivasan and V. Subrahmanyan

(Central Food Technological Research Institute, Mysore)

The diets consumed by a vast majority of the people belonging to the low income groups of the population in India consist predominantly of cereals and millets and contain only small quantities of pulses, vegetables, milk and other animal products[1]. Such diets, in general, have been found to be deficient in proteins of high biological value and certain vitamins and minerals and do not promote optimum growth in children[2-4]. Considerable amount of work has been done by several workers in India and other countries on the development of supplementary foods based on locally available protein-rich foods of vegetable origin, suitable for supplementing the diets of the vulnerable sections of the population.[5-8] In the earlier papers of this series, the results of studies on the preparation and nutritive value of a high protein food based on groundnut protein isolate have been reported[9,10]. The present paper describes the results of studies on the supplementary value of high protein food to a poor Indian rice diet.

Experimental

Material: The high protein food used in this study was the same as that described in an earlier paper of this series[9]. Spray-dried skim milk powder of good quality was used. The chemical composition of this food has been given in the preceding papers[9].

Animal experiments: The supplementary value of high protein food and skim milk powder to a poor rice diet was determined by growth experiments on albino rats. Three groups of freshly weaned albino rats weighing about 45 g. (12 in each group distributed equally according to sex and body weight and allotted in randomized block design) were fed on poor rice diet and the same diet in which a part of the rice was replaced by an equal quantity of high protein food or skim milk powder, so as to provide 5 per cent extra protein. The composition of the experimental diets is given in Table I. Another group of weanling rats weighing about 45 g. was used to

Table I. *Percentage composition of experimental diets*

Constituents	Poor rice diet	Poor rice diet + high protein food	Poor rice diet + skim milk powder
Rice	78.5	72.1	64.9
High protein food	—	6.4	—
Skim milk powder	0.9	0.9	14.8*
Red gram dhal (*cajanus cajan*)	5.0	5.0	5.0
Groundnut oil	5.0	5.0	5.0
Common salt	0.3	0.3	0.3
Non-leafy vegetables potatoes and brinjal (*Solanum melongena*)	8.2	8.2	8.2
Leafy vegetables (*Amaranthus gangeticus*)	2.1	2.1	2.1

* This included an additional supplement of 13.9 g. of skim milk powder providing 5 per cent of extra protein.

determine the initial body composition. The methods adopted for the preparation of the diets and the feeding of the experimental animals were the same as those described by Subrahmanyan *et al*[11].

Records of the daily food intake were kept for all the groups and the rats were weighed every week. After the 8 week feeding period, the haemoglobin and red blood cell count in the blood of rats were determined according to Joseph *et al*[12]. The histological examination of the livers of female rats was carried out according to the methods used by Venkata Rao *et al*[13]. The moisture, fat and nitrogen contents of the livers and carcasses were determined according to Joseph *et al*[12]. The results are given in Tables II—IV.

Results and Discussion

Weight gain and composition of blood: The results presented in Table II show that the protein food and skim milk powder when incorporated in poor rice diet to provide 5 per cent extra protein produced a highly significant ($P<0.001$) increase in the weight of rats. There were no significant differences in the mean increases in weight of rats receiving skim milk powder or the protein food. The mean haemoglobin level and red blood cell counts of rats receiving the supplements of protein food or skim milk powder were significantly greater than those of rats receiving the rice diet alone.

Composition of liver and carcass: The results of analysis of the livers and carcasses of rats fed on the different diets are given in Table III. No significant differences were observed in the mean fat and protein contents of the livers and carcasses of the rats receiving the supplements of high protein food or skim milk powder. The mean fat content of the livers of rats fed on the control rice diet was significantly higher than those of the rats receiving the protein supplements. There were no significant differences in the mean protein contents of the carcass of rats fed on the rice diet and the same supplemented with the high protein food.

Histological structure of liver: The livers of animals receiving the rice diet showed mild degrees of parenchymal damage of the protein deficiency type. Varying degrees of cytoplasmic vacuolation of the protein deficiency type were observed. The livers showed no signs of fatty infiltration. The liver sections of rats receiving the protein supplements were normal indicating thereby that the high protein food is as effective as skim milk powder in correcting the deficiency of protein in the rice diet and in preventing liver damage.

Intake and retention of protein: Data regarding the intakes and retentions of protein by the rats fed on the different diets are presented in Table IV. No significant differences were observed in the mean retention of protein per 100 g.

TABLE II. *Growth and composition of blood of rats fed on poor rice diet supplemented with high protein food and skim milk powder*

(Period of experiment: 8 weeks, mean values for 6 male and 6 female rats in each group)

Group	Diet	Protein content of diet[1] %	Initial body weight (g)	Daily food intake[1] (g)	Weekly gain in body weight (g)		Haemoglobin (g/100cc)		Red blood cells (10^6/cu.mm)	
A	Poor rice diet	8.28	48.6	6.4	4.16	± 0.22 (20 d.f.)	14.29	± 0.18 (20 d.f.)	6.19	± 0.12 (20 d.f.)
B	Poor rice diet + high protein food	13.20	48.5	8.8	10.14		15.83		7.65	
C	Poor rice diet + skim milk powder	13.14	48.6	8.9	10.74		16.17		7.84	
	Critical difference at 5% level				0.53		0.43		0.29	
	,, 1% ,,				0.78		0.62		0.43	
	,, 0.1% ,,				1.10		0.88		0.61	

[1] Expressed on moisture-free basis.

TABLE III. *Chemical composition of livers and carcasses of rats fed on poor rice diet supplemented with high protein food and skim milk powder*

(Experimental period: 8 weeks, mean values for 6 males in each group)

Group	Diet	Weight of fresh liver (g)	Liver						Body Weight (g)	Carcass					
			Moisture (%)		Fat (%)		Protein (%)			Moisture (%)		Fat (%)		Protein (%)	
A	Poor rice diet	3.5	71.5	±0.29*	4.02	±0.21*	17.80	±0.22*	84.7	61.4	±0.35*	13.3	±0.53*	18.0	±0.37*
B	Poor rice diet + high protein food	5.5	70.8		3.06		18·32		137.5	58.1		17.5		18.9	
C	Poor rice diet + skim milk powder	5.7	70.7		3.08		18.40		146.3	57.8		17.7		19.3	
	Critical diff. at 5% level		0.7		0.53		0.55			0.9		1.4		0.9	
	,, 1% ,,		1.1		0.80		0.84			1.3		2.1		1.4	
	,, 0.1% ,,		1.7		1.21		1.26			2.0		3.1		2.2	

* Standard error based on 10 degrees of freedom.

TABLE IV. *Intake and retention of protein in rats fed on poor rice diet supplemented with high protein food and skim milk powder*

(Experimental period: 8 weeks; mean values for 6 males in each group)

Group	Diet	Total protein intake (g)	Total increase in body weight (g)	Initial body protein (g)	Total body protein (g)	Protein retained (g)	Protein retained per 100g. increase in body weight	
A	Poor rice diet	29.7	35.3	8.79	15.25	6.46	18.19	±0.70 (10 d.f.)
B	Poor rice diet + high protein food ...	65.1	88.1	8.79	25.94	17.15	19.38	
C	Poor rice diet + skim milk powder ...	65.5	97.1	8.77	28.25	19.48	20.01	

Critical difference at 5% level	1.78
,, 1% level	2.72
,, 0.1% level	4.07

increase in body weight of rats fed on the rice diet or the same supplemented with high protein food showing thereby that the increase in body weight was followed by a corresponding increase in body protein as well.

The results obtained in the present investigation showed that supplementation of a rice diet with high protein food based on groundnut protein isolate so as to provide 5 per cent extra protein in the diet, resulted in a significant increase in the growth of rats. It would be of interest to note that the protein food when providing 5 per cent extra protein and adequate amounts of calcium and certain vitamins was as effective as skim milk powder in making up the deficiencies in the poor rice diet and in promoting the growth of rats. The supplementary effect of high protein food was of the same order of magnitude as that observed earlier with Indian multipurpose food.[14]

Summary

1. Supplementation of a poor Indian rice diet with high protein food based on groundnut protein isolate or skim milk powder to provide 5 per cent extra protein in the diet resulted in highly significant increases in the mean weekly growth rates of rats receiving the two protein supplements.

2. The mean fat content of the livers of rats fed on the control rice diet was significantly higher than that of rats receiving diets containing the protein supplements. Livers of animals fed on the rice diet showed mild to moderate degree of parenchymal damage of the protein deficiency type, while those of rats receiving the protein supplements were quite normal.

3. No significant differences were observed in the mean retentions of protein per 100 g. increase in body weight of rats fed on the rice diet or the same supplemented with protein foods.

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SUPPLEMENTARY VALUE OF A HIGH PROTEIN FOOD BASED ON GROUNDNUT PROTEIN ISOLATE TO A MAIZE-TAPIOCA DIET

By P. K. Tasker, A. Paul Jayaraj, M. Narayana Rao, K. Indiramma,
M. Swaminathan, A. Sreenivasan and V. Subrahmanyan

(*Central Food Technological Research Institute, Mysore*)

Maize and tapioca form the staple food of a large section of the population in Africa and Latin America[1,2]. The incidence of protein malnutrition is particularly high among children subsisting on maize-tapioca diets[3]. The problem of providing supplementary foods based on locally available protein-rich foods of vegetable origin has been engaging the attention of several workers[4-6]. Tasker *et al*[7] reported that a protein food (based on 1:2:1 blend of coconut meal, groundnut flour and Bengalgram flour fortified with essential vitamins and calcium salts) when incorporated to provide 10 per cent extra protein in a maize-tapioca diet made up the deficiencies in the diet and promoted good growth in rats. The present paper deals with studies on the supplementary value of a high protein food based on groundnut protein isolate as compared with that of Indian multipurpose food (a 3:1 blend of groundnut flour and Bengalgram flour fortified with vitamins and calcium salts) and skim milk powder to a low-protein diet based on maize and tapioca.

Experimental

High protein food: This was prepared according to Subrahmanyan *et al*[8].

Indian multipurpose food: This was prepared according to Subrahmanyan *et al*[9].

Skim milk powder: Spray-dried skim milk powder of good quality was used.

The chemical compositions of these foods have already been reported in a preceding paper.[8]

Animal experiments: The supplementary value of the high protein food, as compared with that of Indian multipurpose food and skim milk powder to a maize-tapioca diet was determined by growth experiments on albino rats. Weanling albino rats (Wistar strain) weighing about 40-45 g. were used for the investigation. Each group contained 12 rats equally divided according to sex and body weight. The animals were grouped according to a randomized block design and were housed in individual cages with metal-screen bottoms. They were fed on the different experimental diets, the compositions of which are given in Table I. Sufficient quantities of different protein foods were incorporated by replacing an equal amount of tapioca flour, so as to provide 15 per cent extra protein in the diet. A separate group of weanling rats in the same weight range were used for determining the initial body composition. Weighed amounts of the diets were cooked with three times the amount of water by steaming and fed to the rats. Records of food intake and weekly gain in weight were maintained for all the groups of rats. After feeding for a period of 8 weeks, the haemoglobin content and red blood cell counts were determined from the blood drawn from the tail veins according to the methods of Joseph *et al.*[10] The animals were anaesthetized with ethyl ether. Blood was drawn by heart puncture and the serum was separated. The total

Table I. *Composition of experimental diets*

Constituents	Maize-tapioca diet (Control)	Multi-purpose food	High-protein food	Skim-milk powder
Maize flour	30.0	30.0	30.0	30.0
Tapioca flour	60.0	24.5	40.8	20.6
Salt mixture[1]	2.0	2.0	2.0	2.0
Vitaminised starch[2]	1.0	1.0	1.0	1.0
Groundnut oil[3]	6.0	6.0	6.0	6.0
Sodium chloride	1.0	1.0	1.0	1.0
Protein food[4]	—	35.5	19.2	39.4

[1] Hubbel, Mendel and Wakeman salt mixture.

[2] Vitaminised starch of Chapman *et al.*[12]

[3] Contained added vitamins A, D, E and K.

[4] The different protein foods contributed 15 per cent protein and replaced an equal amount of tapioca flour in the control diet.

serum protein content was determined according to King and Wootton[11]. The electrophoretic pattern of the serum proteins was studied according to Tasker *et al*[7].

The livers were removed and analysed for moisture, fat and protein according to Joseph *et al*[10]. The contents of the gastro-intestinal tract were removed by squeezing and the whole carcass was weighed and minced. The moisture, protein and fat in the carcass were determined according to methods used for liver. The initial protein contents of the carcass of rats in the different groups were calculated from the values obtained for a group of weanling rats of the same weight range. Using this data, the retention of protein in the carcass of rats receiving the protein supplements over a period of 8 weeks was calculated.

Histological examination of the liver: Portions of the liver were taken from the left lobe and fixed in 10 per cent formalin. The tissues were processed through paraffin. Sections of 5μ. thickness were stained with haemotoxylin and eosin. In addition, frozen sections were taken from each specimen and stained with Sudan IV in propylene glycol for studying the distribution of fat.

Results

The results are presented in Tables II-VI.

Growth and composition of blood: The average weekly increase in weight of rats fed on the different diets is shown in Table II. The results show that incorporation of the different protein foods in the maize-tapioca diet so as to provide 15 per cent extra protein (Table I) resulted in a highly significant ($P<0.001$) increase in the growth rate of rats. The rats on the control (maize-tapioca) diet did not grow and actually lost weight during the 8 weeks' feeding period. There were no significant differences, however, in the growth rates of rats receiving the different protein foods. The serum proteins, haemoglobin and red blood cell count of rats receiving the supplements of protein foods (Table III) were significantly higher ($P<0.001$) than those of the control (maize-tapioca) diet. The serum of rats fed on the maize-tapioca diet had a lower albumin content and a higher gamma globulin content than the rats receiving supplements of the different protein foods.

Composition of liver and carcass: The results of analysis of liver and carcass of rats fed on the different diets are shown in Tables IV and V. There were no significant differences in the mean protein and fat contents of the livers and carcasses and in the mean xanthine oxidase activity of the livers of rats receiving the different protein foods. The mean fat content of livers of rats fed on the maize-tapioca diet was significantly higher ($P<0.001$) than those of rats receiving the protein foods. The mean xanthine oxidase activity of the livers of rats receiving the maize-tapioca diet was significantly lower ($P<0.001$) than those of rats receiving the different protein foods. The mean protein content of the carcass of rats fed on maize-tapioca diet was also significantly lower ($P<0.001$) than those of animals receiving the protein foods.

Histological structure of liver: Livers of animals on the maize-tapioca diet showed a mild to moderate degree of parenchymal damage of the protein deficiency type (Fig. 1). The liver cells showed reduction in cytoplasmic protein. Varying degrees of cytoplasmic vacuolation of the protein deficiency type were observed. Frozen sections (Fig. 2) stained with Sudan IV showed abundant stainable fat around periportal areas. Fatty infiltration was not seen around the central vein. Necrosis of the liver cells was absent. The liver sections of rats receiving the different protein foods were quite normal (Figs. 3-5) indicating thereby that the high protein food was as effective as skim milk powder in correcting the deficiencies of protein and other dietary essentials in the diet and in preventing liver damage.

Intake and retention of protein: The intake and retention of protein by the rats fed on the different diets are shown in Table VI. No significant differences were observed in the mean retentions of protein per 100 g. increase in body weight of rats receiving the different protein foods. On the other hand, the rats fed on the maize-tapioca diet for a period of 8 weeks lost some body proteins.

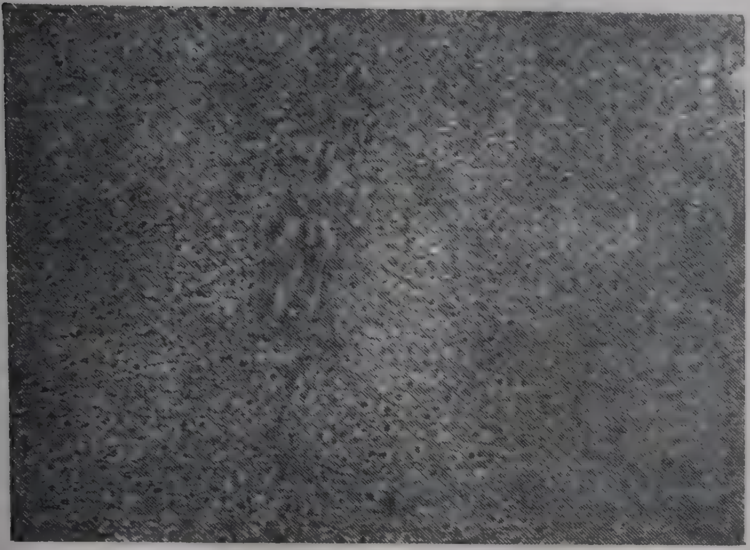

FIG. 1

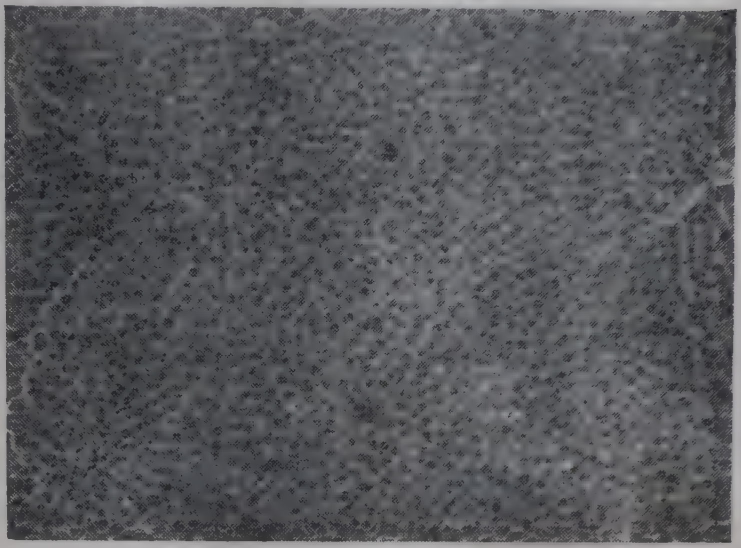

FIG. 4

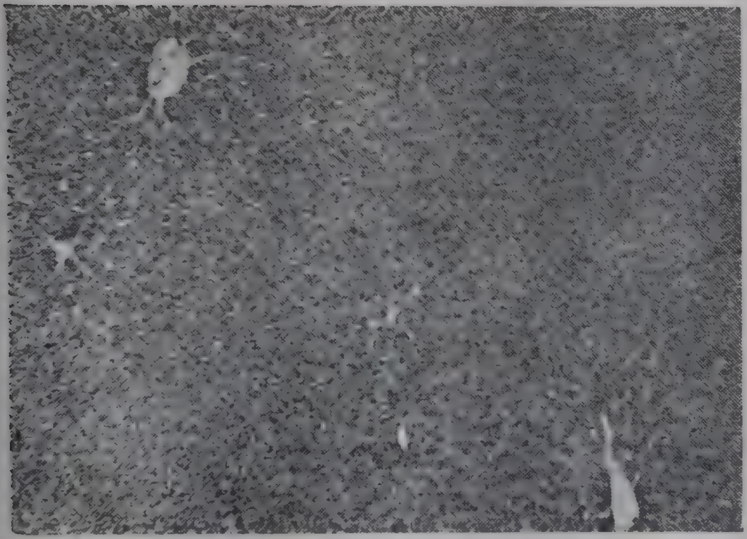

FIG. 2

1. Liver of rat fed on control maize-tapioca diet. Vacuolation of hepatic cells is prominent in periportal area. Haemotoxylin and eosin × 100.

2. Liver of rat fed on control maize-tapioca diet. Lipid is prominent in hepatic cells in periportal areas. Sudan iv × 100.

3. Liver of rats receiving supplements of multipurpose food showing normal histological picture. Haemotoxylin and eosin × 100.

4. Liver of rats receiving supplements of high protein food showing normal histological picture. Haemotoxylin and eosin × 100.

5. Liver of rats receiving supplements of skim milk powder showing normal histological picture. Haemotoxylin and eosin × 100.

FIG. 3

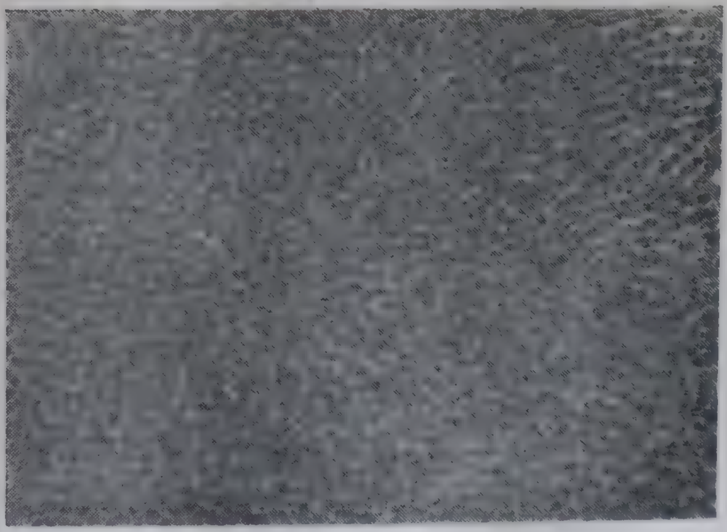

FIG. 5

TABLE II. *Gain in body weight of rats on a maize-tapioca diet supplemented with different protein foods*

(6 males and 6 females in each group ; duration of experiment ; 8 weeks)

Group	Diet	Average initial body weight (g)	Average final body weight (g)	Protein content of the diet (moisture free basis) (g)	Average daily food intake (moisture free basis) (g)	Average weekly gain in body weight* (g)	
A	Maize-tapioca diet (control) ...	42.3	41.2	5.08	6.8	-0.14	
B	Control + multipurpose food ...	42.4	188.0	19.9	10.5	18.2	±0.74 (20 d.f.)
C	Control + high protein food ...	42.0	178.0	20.1	10.4	17.0	
D	Control + skim milk powder ...	42.3	180.7	19.9	10.2	17.3	

Critical difference at 5% level 2.2

* Statistical analysis of the average weekly gain in body weight was carried out by omitting the control group (maize-tapioca diet) as the gain in weight for most of the rats on the control diet was very low and in a number of cases, the animals lost weight.

TABLE III. *Composition of blood of rats fed on maize-tapioca diet supplemented with different protein foods*

Diet	Haemoglobin[1] g/100cc.		Red blood cell count[1] (10^6/cu.mm.)		Total serum protein[2] (g/100cc.)		Electrophoretic serum protein pattern[2] Expressed as % of total serum proteins: Albumin		Alpha$_1$ globulin		Alpha$_2$ globulin		Beta globulin		Gamma globulin	
Maize-tapioca diet (control) ...	12.07	±0.287 (30 d.f.)	4.73	±0.126 (30 d.f.)	4.5	±0.07 (15 d.f.)	24.2	±0.65 (15 d.f.)	19.6	±0.59 (15 d.f.)	17.6	±0.83 (15 d.f.)	19.4	±0.96 (15 d.f.)	19.2	±1.01 (15 d.f.)
Control + multipurpose food	15.62		7.65		6.5		35.1		18.9		10.9		22.5		12.6	
Control + high protein food ...	15.67		7.47		6.6		35.6		18.5		10.8		23.2		11.9	
Control + skim milk powder...	15.92		7.44		6.6		37.9		18.5		10.0		23.5		10.0	
Critical difference at 5% level:	0.80		0.36		0.20		1.97		1.77		2.50		2.88		3.05	
,, 1% ,,	1.08		0.49		0.27		2.73		2.45		3.46		3.99		4.22	
,, 0.1% ,,	1.43		0.65		0.37		3.77		3.38		4.79		5.51		5.83	

[1] Average of 6 males and 6 females in each group.
[2] Average of 6 males per group.

Discussion

A diet based mainly on a 1:2 blend of maize and tapioca contained only 5 per cent protein of low nutritive value and did not promote growth in rats. Supplementation of the above diet with 15 per cent extra protein from a high protein food based on groundnut protein isolate, Indian multipurpose food or skim milk powder made up the deficiencies in the diet and promoted good growth in the experimental animals, there being no significant differences in this respect between the different protein foods. The livers of rats receiving the different protein foods had a normal histological appearance, while those of rats receiving the maize-tapioca diet showed cytoplasmic vacuolation and periportal fatty infiltration. The results obtained in the present study showed that the high protein food and the multipurpose food were as effective as skim milk powder in correcting the deficiencies of protein in the maize-tapioca diet and in preventing liver damage. The mean xanthine oxidase activity

TABLE IV. *Composition of liver of rats fed on maize-tapioca diet supplemented with different protein foods*
(Values are averages of 6 male rats in each group)

Diet	Average weight of fresh liver (g)	Composition of liver: Moisture %		Protein %		Fat %		Xanthine oxidase activity* μlO_2/g./hr.	
Maize-tapioca diet (control)	1.98	71.5	±0.49 (15 d.f.)	12.8	±0.19 (15 d.f.)	5.2	±0.19 (15 d.f.)	63.0	±20.5 (10 d.f.)
Control + multipurpose food	8.02	71.8		18.9		3.4		411.0	
Control + high protein food	7.55	69.6		18.6		3.1		410.0	
Control + skim milk powder	7.97	71.5		19.2		2.8		479.0	
Critical difference at 5% level		1.48		0.56		0.55		64.7	
" 1% "		2.05		0.78		0.76		92.0	
" 0.1% "		2.83		1.07		1.05		133.2	

* Statistical analysis of the xanthine oxidase activity of the liver was carried out by omitting the control (maize-tapioca diet) group as the xanthine oxidase activity of this group of rats was very low.

TABLE V. *Composition of the body of rats fed on maize-tapioca diet supplemented with different protein foods*
(Values are averages of 6 male rats in each group)

Diet	Average body weight (g)	Composition of the body: Moisture %		Protein %		Fat %	
Maize-tapioca diet (control) ...	42.7	68.2	±0.55 (15 d.f.)	14.4	±0.22 (15 d.f.)	9.1	±0.57 (15 d.f.)
Control + multipurpose food ...	222.2	58.1		18.2		17.6	
Control + high protein food ...	215.4	58.5		18.2		17.9	
Control + skim milk powder ...	212.6	58.6		18.3		17.5	
Critical difference at 5% level		1.65		0.65		1.72	
" 1% "		2.28		0.90		2.38	
" 0.1% "		3.14		1.24		3.28	

in the livers of rats receiving the control (maize-tapioca) diet was very low. Supplementation of the diet with the different protein foods, so as to provide 15 per cent extra protein also caused a significant increase in the activity of the enzyme. Also, a high protein food based on groundnut protein isolate and fortified with essential vitamins and minerals could be used as an effective supplement to maize-tapioca diets and that there is considerable scope for the production and use of such products as supplements to the diets of children in several countries where groundnut is available in plenty.

Summary

1. A diet based on a 1:2 blend of maize and tapioca contained only 5 per cent protein and did not promote any growth in albino rats. Supplementation of the diet with a high protein food based on a blend of groundnut protein isolate (85 parts) and Bengalgram flour (15 parts) fortified with vitamins and minerals so as to provide 15 per cent extra protein in the diet made up the deficiencies in the diet and promoted a highly significant ($P<0.001$) increase in the growth of rats.

2. The serum of rats receiving the maize-tapioca diet had a lower albumin content and a higher gamma globulin content than that of rats receiving the protein foods.

3. The mean fat content of the livers of rats fed on the maize-tapioca diet was significantly higher ($P<0.001$) and protein content significantly lower ($P<0.001$) than that of rats receiving the protein foods. The mean xanthine oxidase activities of the livers of rats receiving the protein supplements were significantly higher ($P<0.001$)

TABLE VI. *Intake and retention of protein in rats on a maize-tapioca diet supplemented with different protein foods*

(Duration of experiment : 8 weeks ; values are averages of 6 male rats in each group)

Group	Diet	Total protein intake (g)	Total increase in body weight (g)	Body protein		Protein retained		
				Initial* (g)	Final (g)	g.	g./100g. increase in body weight	
A	Maize-tapioca diet (control) ...	18.9	0.5	7.6	6.1	...	...	
B	Control + multipurpose food ...	125.0	180.0	7.6	40.4	32.8	18.23	± 0.23 (10 d.f.)
C	Control + high protein food ...	117.0	173.6	7.5	39.0	31.5	18.14	
D	Control + skim milk powder ...	115.8	170.4	7.6	38.6	31.0	18.20	

Critical difference at 5% level 0.74

* Calculated at 18.0% of the initial weight.

than that of rats fed on the control maize-tapioca diet.

4. The mean protein content of the carcass of rats fed on the maize-tapioca diet was significantly lower than that of rats receiving the protein supplements.

5. The livers of rats fed on the maize-tapioca diet showed moderate degree of parenchymal damage of the protein deficiency type and severe periportal fatty infiltration. On the other hand, the livers of rats receiving the supplements of different protein foods were quite normal, indicating thereby that a high protein food based on groundnut protein and Indian multipurpose food when providing 15 per cent extra proteins were as effective as skim milk powder in correcting the protein deficiency in the diets and in preventing liver damage.

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EFFECT OF SUPPLEMENTARY HIGH PROTEIN FOOD ON THE GROWTH AND NUTRITIONAL STATUS OF SCHOOL CHILDREN, SUBSISTING ON A POOR INDIAN DIET BASED ON WHEAT

By T. R. Doraiswamy, Kantha Joseph, Myna Panemangalore, A. N. Sankaran,
R. Rajagopalan, M. Swaminathan, A. Sreenivasan and V. Subrahmanyan

(*Central Food Technological Research Institute, Mysore*)

Diet and nutrition surveys carried out in India have shown that the diets consumed by children, especially of low income groups, are deficient in proteins, certain vitamins and minerals and as a consequence of which their rate of growth is sub-optimal[1,2]. Recent investigations have shown that processed protein foods based on oilseed meals and legumes can be used as effective supplements to their diets[3-5]. In the preceding papers of this series, the results of studies relating to the preparation and nutritive value of a high protein food based on groundnut protein isolate have been reported[6-9]. The present paper deals with studies carried out to determine the supplementary value of the food to the diet of school children.

Experimental

High Protein food: The high protein food (seasoned) used in this study was the same as that described in an earlier paper[6]. The nutrients provided by one ounce (28.4 g.) of the food are given in Table I.

Table I. *Nutrients in 1 oz. (28.4 g.) of high protein food based on groundnut protein isolate*

Protein (Nitrogen × 6.25) (g)	...	22.2
Fat (g)	...	0.4
Carbohydrate (g)	...	2.8
Calcium (mg)	...	390.0
Phosphorus (mg)	...	213.0
Iron (mg)	...	0.4
Thiamine (mg)	...	0.88
Riboflavin (mg)	...	1.74
Nicotinic acid (mg)	...	8.1
Vitamin A (I.U.)	...	1714.
Vitamin D (I.U.)	...	172
Calories (Kcal)	...	106

Subjects: The investigations were carried out in a boarding home containing 72 girls, ranging in age from 4 to 15 years. All the children were examined clinically. Forty-two girls aged 4-12 years free from diseases likely to interfere with the studies were selected for the experiment.

Physical measurements and assessment of nutritional status: Height, weight, nutritional status, red blood cell count and haemoglobin content of the blood were determined according to the methods used by Reddy *et al*[10]. On the basis of initial height, weight and nutritional status, the children were paired and the members of each pair were allotted at random to two groups.

Composition of experimental diets and feeding of children: The pattern of diets consumed by the children is given in Table II. The diet was based mainly on wheat and contained small amounts of rice, pulses, vegetables and skim milk

Table II. *Diets consumed by the children*

Food		Intake (g/child/day)
Basal diet common to both groups (wheat diet)		
Wheat flour—whole	...	205.5
Rice, raw, milled	...	68.3
Pulses Bengalgram dhal (*Cicer arietinum*) and horse gram (*Dolichos biflorus*)	...	10.2
Vegetables non-leafy: radish, brinjal, calabash cucumber, fresh beans, tomato, (green) onions and vegetable marrow	...	45.4
Condiments and spices: red chillies, coriander seeds, garlic and turmeric	...	1.2
Tamarind (*Tamarindus indicus*) pulp from the fruit	...	1.4
Skim milk powder	...	8.9
Common salt	...	5.5
Jaggery	...	28.0
Groundnut oil	...	2.1
Supplements:		
Control Group: rice	...	14.2
sugar	...	14.2
Experimental group: high protein food	...	28.4

The mean consumption unit for both the groups calculated from the international scale of family co-efficients (League of Nations, Health Organization 1932) was found to be 0.8.

powder. The nutritive value of the diets consumed by the two groups was calculated on the basis of figures given by Aykroyd *et al*[11]. The results, together with the dietary requirements suggested by the Indian Council of Medical Research: Nutritional Advisory Committee[12] for children of similar age group, are given in Table III. The pattern of breakfast, lunch and dinner was similar to that described by Reddy *et al*[10].

TABLE III. *Mean daily intake of different nutrients by the children compared with standard recommended allowances*

Nutrients	Control group	Experimental group	N.A.C.* Standard
Calories (Cal)	1313	1313	2000
Protein (N × 6.25) (g)	37.0	59.0	57.0
Fat (g)	9.9	10.1	—
Carbohydrate (g)	268.9	246.5	—
Calcium (Ca) (g)	0.302	0.690	1-1.5
Phosphorus (P) (g)	0.834	1.040	—
Iron (Fe) (mg)	16.8	17.3	10-30
Vitamin A.			
as vitamin A (I.U.)	—	1714	3000-4000
as carotene (I.U.)	352	352	
Thiamine (mg)	1.23	2.11	0.5-1.0
Riboflavin (mg)	0.59	2.47	1.8†
Nicotinic acid (mg)	12.1	20.9	12.0†
Ascorbic acid (mg)	36.0	36.0	30-50
Vitamin D (I.U.)	—	172	400

* Recommendations of the Indian Council of Medical Research: Nutrition Advisory Committee (1944).

† Recommendations of the (U.S.A.) National Research Council: Food and Nutrition Board (1948).

In addition to the orphanage diet, each subject in the experimental group was given daily a supplement of one ounce of high protein food (half ounce with lunch and half ounce with dinner) in the form of *chutney*. In order to equalise the calorie intake of the two groups, each subject in the control group was given daily rice pudding prepared from half ounce of rice flour and half ounce of sugar. The pudding was served along with lunch and dinner. All the subjects relished the supplements and none complained of any digestive trouble. The experiment lasted for a period of six months at the end of which, height, weight, nutritional status, red blood cell count and haemoglobin content of the blood were determined.

Results and Discussion

The initial and final values for height, weight, haemoglobin level and red blood cell count of the subjects in the two groups are given in Table IV and for nutritional status in Table V. For the purpose of statistical analysis, the increases in the various measurements at the end of the experimental period were obtained for each subject and the mean for each group calculated. The difference in the mean increase for any one criterion between the two groups was tested by the '*t*' test appropriate for paired comparisons. It could be seen that the mean increases in height, weight and haemoglobin level in the experimental group were greater than those observed in the control group, the differences being significant at 0.1 per cent level for the first two and at 5 per cent level for haemoglobin. The data given in Table V show that thirteen children in the experimental group improved in their nutritional status as compared with only 3 children in the control group. Further, 6 children in the control group deteriorated in their nutritional status, while none in the experimental group showed any deterioration.

It is of interest to compare the results of this study with those obtained in earlier studies with groundnut curds and Indian multipurpose food. Subrahmanyan *et al*[3,13] reported that supplementation of the diets of children with 12 ounces daily of groundnut curd or 2 ounces daily of Indian multipurpose food brought about a significant improvement in the growth and nutritional status of children. The improvement in the growth and nutritional status observed in the present study with a daily supplement of one ounce of high protein food is almost equal to that observed earlier with a daily supplement of 12 ounces of groundnut curds or 2 ounces of Indian multipurpose food[3,13]. It may be concluded from the results obtained in this and an earlier investigations[3] that processed protein foods based on groundnut flour or groundnut protein isolate and fortified with essential vitamins and minerals could be used as effective supplements to the diets of children in regions where milk and other protective foods are not available in adequate amounts.

TABLE IV. *Mean values for the initial and final measurements of the children in the control and experimental groups*
(Twenty-one girls in each group)

Character	Control group (*a*)			Experimental group (*b*)			Results of statistical analysis	
	Initial	Final	Increase	Initial	Final	Increase	Difference in increase (*b-a*)*	Significance of the difference
Height (cms.)	112.47	114.20	1.73	118.32	121.04	2.72	0.99 ± 0.21	Significant at 0.1%
Weight (kg)	17.99	18.62	0.63	17.87	19.11	1.24	0.62 ± 0.10	Significant at 0.1%
Haemoglobin (g/100 ml.)	12.41	12.56	0.15	12.22	12.77	0.55	0.41 ± 0.21	Significant at 5.0%
Red blood cell count (10/^{6} cu. mm)	4.31	4.41	0.10	4.14	4.36	0.22	0.12 ± 0.09	Not significant

* Value with its standard error.

TABLE V. *Nutritional status of children in the control and experimental groups*

Nutritional score	Initial nutritional status of children		Changes in the nutritional status of children					
			Control group (No. of children)			Experimental group (No. of children)		
	Control group (No. of children)	Experimental group (No. of children)	Improved	Stationary	Deteriorated	Improved	Stationary	Deteriorated
0	4	6	...	2	2	...	6	...
1	6	6	1	3	2	6	...	...
2	6	6	1	4	1	4	2	...
3	5	...	1	3	1	...	...	...
4	...	2	...	...	...	2	...	...
5	...	1	...	...	...	1	...	...
Total	21	21	3	12	6	13	8	...

Summary

1. A feeding experiment extending over a period of 6 months was carried out on two groups of girls aged 4-12 years (21 girls in each group) to assess the value of supplementing their diets with one ounce of a high protein food based on groundnut protein isolate and fortified with certain vitamins and minerals.

2. The children were paired according to initial height and weight and the members of each pair allotted at random to the control and experimental groups. Values for height, weight, red-cell count and haemoglobin level were obtained at the beginning and end of the experiment, for subjects in the control and experimental groups.

3. There was a significant increase in height, weight and haemoglobin level of subjects receiving the supplement as compared with the control group. Thirteen children in the experimental group improved in their nutritional status as compared with only three children in the experimental group. Further, six children in the control group, deteriorated in nutritional status, while none in the experimental group showed any deterioration.

Acknowledgment

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EFFECT OF SUPPLEMENTARY HIGH PROTEIN FOOD ON THE RETENTION OF NITROGEN, CALCIUM AND PHOSPHORUS IN CHILDREN SUBSISTING ON A POOR WHEAT DIET *

By MYNA PANEMANGALORE, H. N. PARTHASARATHI, KANTHA JOSEPH, M. NARAYANA RAO, K. INDIRAMMA, R. RAJAGOPALAN, M. SWAMINATHAN, A. SREENIVASAN AND V. SUBRAHMANYAN

(*Central Food Technological Research Institute, Mysore*)

Metabolism studies carried out on children (boys and girls aged 9-11 years) subsisting on poor Indian diets consisting predominantly of rice, jowar (*Sorghum vulgare*), ragi (*Eleucine coracana*) and bajra (*Pennisetum typhoides*) show that the children maintained slight positive nitrogen and calcium balances except on ragi diets which were inadequate for promoting optimum growth of children[1-4]. Subrahmanyan *et al*[5] and Joseph *et al*[6] reported that supplementation of poor rice diet daily with 2 oz., of Indian multipurpose food (based on a 3:1 blend of groundnut flour and Bengalgram flour, fortified with vitamins and minerals) brought about significant increases in the growth and nutritional status as also in the retention of nitrogen, calcium and phosphorus in children. In the preceding paper, Doraiswamy *et al*[7] reported that supplementation of the diet of undernourished children daily with 28.4 g. (1 oz.) of high protein food (based on groundnut protein isolate, fortified with essential vitamins and minerals) for a period of 6 months brought about a marked improvement in their growth and nutritional status. The present paper deals with studies on the effect of the protein food supplement on the metabolism of nitrogen, calcium and phosphorus in children.

Experimental

Subjects: This investigation was carried out when the feeding experiment[7] with the high protein food had been in progress for a period of 3 months. Eight pairs of girls, aged 7-10 years, were selected from among the subjects of the feeding experiment[7] for the metabolism study. The girls of each pair were similar in age, height and weight (Table I). They had been clinically examined and found free from ailments likely to interfere with the experiment.

Experimental diets and feeding of children: The procedure adopted for the metabolic study was the same as that of Joseph *et al*[6]. The composition of diets consumed by the subjects during the metabolic experiment was the same as that consumed by the subjects during the feeding study[7]. The pattern of breakfast, lunch and dinner was also the same. The quantity of foods consumed daily by the subjects was recorded throughout the experimental period. Duplicates of all dishes consumed by each subject were collected daily, dried in an air oven at 80-90°C and weighed. They were powdered and analysed for nitrogen, calcium and phosphorus.

TABLE I. *Ages, heights and weights of the children at the beginning of the test*

Child no.	Age (years)	Height (cm.)	Weight (kg.)
Rice diet			
1	10	126	23.5
2	10	123	20.3
3	10	124	22.6
4	9	124	22.5
5	9	122	23.3
6	8	118	19.8
7	8	112	17.6
8	7	111	17.6
Rice + high protein food			
9	10	125	23.4
10	10	122	21.4
11	10	120	21.4
12	9	124	22.6
13	9	122	23.1
14	8	118	19.7
15	8	110	17.4
16	7	113	17.8

Plan of the experiment: The experimental period lasted 7 days. During the first two days the children were left to get accustomed to the equipment used for the collection of urine and faeces which were collected only during the last 5 days. The methods used for collection and preservation of the urine and faeces were the same as those of Murthy *et al.*[8]

Analytical methods: The methods for the estimation of nitrogen, calcium and phosphorus in food, urine and faeces were the same as those described by Murthy *et al.*[8] All the analyses were carried out in duplicate.

Results

The results for nitrogen metabolism are given in Table II; those of calcium and phosphorus metabolism are given in Table III.

The mean daily intake of calories, protein, calcium and phosphorus on the control diet fell short of the recommended allowances suggested by the Indian Council of Medical Research:

TABLE II. *Mean daily intake, excretion and balance of nitrogen of girls on wheat and wheat-high-protein food diets*

Diet	Intake (g)	Excretion (g)			Apparent digestibility %	Balance (g)
		Urinary	Faecal	Total		
Wheat diet*	5.57	3.33	1.36	4.69	75.5	+ 0.88
Wheat-high protein food diet†	9.06	6.00	1.41	7.41	84.4	+ 1.65
Difference	3.49	2.67	0.05	2.72	8.9	0.77 ± 0.10‡

* Calorie intake: 1313 cal/child/day.

† Calorie intake: 1313 cal/child/day.

‡ Value with its standard error.

TABLE III. *Mean daily intake, excretion and balance of calcium and phosphorus of girls on wheat and wheat-high protein food diets*

Diet	Intake	Excretion			Balance
		Urinary	Faecal	Total	
		Calcium (mg)			
Wheat diet*	290.9	39.5	176.3	215.8	+ 75.1
Wheat-high protein food†	680.0	49.6	383.0	432.6	+ 247.4
Difference	389.1	10.1	206.7	216.8	172.3 ± 14.7‡
		Phosphorus (mg)			
Wheat diet*	806.8	196.9	305.4	502.3	+ 304.6§
Wheat-high protein food†	1,003.0	257.8	321.4	579.2	+ 423.7§
Difference	196.2	60.9	16.0	76.9	119.1 ± 21.0‡

* Calorie intake: 1313 cal/child/day.
† Calorie intake: 1313 cal/child/day.
‡ Value with its standard error.
§ Rounding off error.

Nutrition Advisory Committee.[9] Supplementation of the diet daily with 1 oz. of protein food made up the deficiencies of protein, calcium and vitamins in the control diet.

Nitrogen metabolism: The mean daily intakes of nitrogen by the children on the control wheat diet and wheat-protein food diet were 5.57 g. and 9.06 g. respectively. The mean daily excretion of nitrogen in the faeces and urine were lower in children fed on the control wheat diet than in those fed on the wheat-protein diet. All the subjects on the two diets were on positive nitrogen balance. The mean daily retentions of nitrogen on the wheat-protein diet were 0.88 g. and 1.65 g. respectively, the difference being significant at 0.1 per cent level. The apparent digestibility co-efficient of the proteins in wheat-protein diet (84.4) was significantly higher than that of the proteins in wheat diet (75.5).

Calcium metabolism: All the children on the two diets were in positive calcium balance. The mean daily intakes on the wheat diet and wheat-protein diet were 290 and 680 mg. respectively. The mean daily calcium retentions were 75 mg. and 247 mg. respectively, the difference being significant at 0.1 per cent level.

Phosphorus metabolism: The mean daily intakes of phosphorus on the wheat diet and wheat-protein diet were 807 and 1003 mg. respectively. All the subjects in the two groups were in positive phosphorus balance. The mean daily phosphorus retention on the wheat-protein diet (424 mg.) was greater than that observed on wheat diet (305 mg.) the difference being significant at 1 per cent level.

Discussion

It is evident from the results, that supplementation of a wheat diet daily with 1 oz. of high protein food based on groundnut protein isolate fortified with vitamins and minerals brought about significant increases in the retention of nitrogen, calcium and phosphorus. The calorie intake of the children (1313 Cal), fell far below the recommended allowance of the Nutrition Advisory Committee[9] for the girls of this age group. In spite of the inadequate calorie intake, consumption of extra protein resulted in a significant increase in the retention of nitrogen. Similar observations were made by Joseph *et al*[6] in their studies with Indian multipurpose food. The results obtained in the present study and those reported by Doraiswamy *et al*[7] in the preceding paper demonstrated clearly that a daily supplement of 28.4 g. of high protein food based on groundnut protein isolate helped to make up the deficiencies in the diet. Since protective foods like milk and milk products are not available in adequate amounts and are not within the reach of the low income groups in many of the developing countries, large scale production and consumption of high protein foods based on groundnut protein isolate will help to a considerable extent in improving the health and nutritional status of children and other vulnerable sections of the population.

Summary

1. The metabolism of nitrogen, calcium and phosphorus was studied in eight pairs of girls aged 7-10 years, similar in age, height and weight, and fed on a diet based on wheat or on the same diet supplemented daily with 28.4 g. of high protein food based on groundnut protein isolate fortified with vitamins and minerals.

2. The mean daily nitrogen intakes on the wheat diet and wheat-protein diet were 5.57g. and 9.06 g. respectively. The apparent digestibility co-efficients of the proteins in the above diets were 75.5 and 84.4 respectively. All the children in the two groups maintained positive nitrogen balance. The mean daily nitrogen retention on the wheat-high protein diet (1.65 g.) was significantly higher ($P<0.001$) than that on the control wheat diet (0.88 g.).

3. The mean daily intakes of calcium on the wheat diet and wheat-high protein diet were 291 and 680 mg. respectively. All the subjects in the two groups were in positive calcium balance. The daily retention of calcium in the subjects on the wheat-high protein food diet (247 mg.) was significantly higher ($P<0.001$) than that observed on the wheat diet (75 mg.).

4. The mean daily intakes of phosphorus on the wheat diet and wheat-high protein diet were 807 mg. and 1003 mg. respectively. All the subjects in the two groups were in positive phosphorus balance. The daily retentions of phosphorus on the wheat-high protein diet (424 mg.) was significantly higher ($P<0.001$) than that observed on the wheat diet (305 mg.).

Acknowledgment

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REFRIGERATED STORAGE OF PLUMS

By H. C. Srivastava and S. D'Souza

(*Central Food Technological Research Institute, Mysore*)

Plums represent a group of temperate fruits belonging to the genus *Prunus*. Japanese plums are attributed to *Prunus Salicina* while European plums come under *Prunus domestica*. According to Giani[1] and Hayes[2] a third group of plums popularly known as *Alu-Bokhara* has been classified as *P. bokhariensis*, but Naik[3] has classified it as a variety of *P. salicina*. The average annual production of plums in India is about 214,000 maunds, the estimated value of which approximates to Rs 87 lakhs. The fruits are grown in Punjab, Uttar Pradesh, Kashmir, Mysore and Madras. Plums are highly perishable (the storage life of plums at room temperature hardly exceeds 5 days[4]) and, therefore, the fruit undergoes enormous spoilage during harvest, transport and storage.

Padfield[5] reported the response of six varieties of plums under refrigerated storage at 32°F and found that only two can be successfully stored. Pentzer[6] found 31-32°F and 85-90 per cent humidity to be the optimum storage conditions with storage life of 3-8 weeks, depending on the variety. Boyles[7] subjected the plums to dual temperature treatment *viz.*, 32°F for the first 5-10 days followed by 45-50°F for further storage. This treatment resulted in extending the storage life of *Santa Rosa*, *Wickson*, and *Gaviota* varieties to 25 days. Smith[8] controlled the internal breakdown of *Victoria* plums stored at 31°F, by keeping them at 65°F for 2 days, once on the 15th day and once on the 20th day during refrigerated storage. The storage life of such plums was extended by 15-20 days at 31°F and subsequently, they ripened normally. However, no work on this problem has so far been done on varieties grown in India.

The present investigation was undertaken to find out the optimum conditions and approximate refrigerated storage life in view of their physiological and biochemical changes during storage.

Materials and Methods

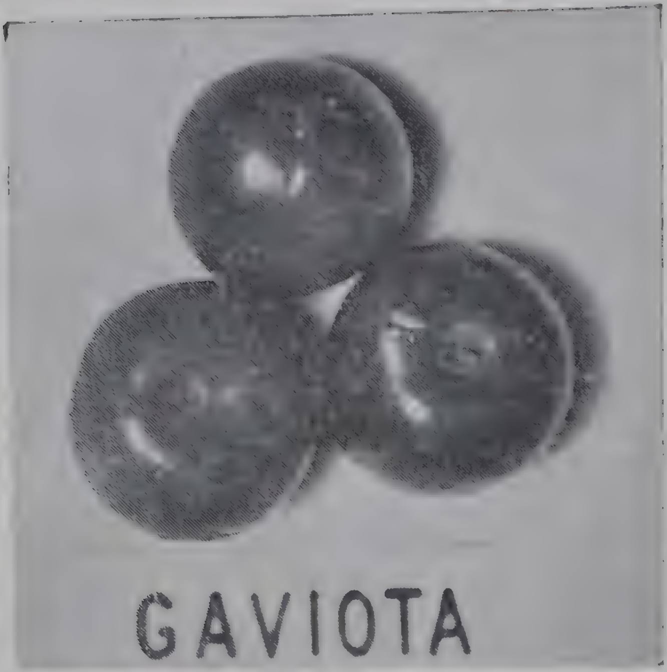
Fully mature fruits of five varieties of Japanese plums (*Prunus salicina*) *viz.*, *Gaviota*, *Shiro*, *Rubio*, *Hale* and *Alu-Bokhara* harvested in the evening from the Pomological Research Station, Coonoor were transported by a special van to Mysore. The characteristics of these varieties are given in Fig. 1 (i-v).

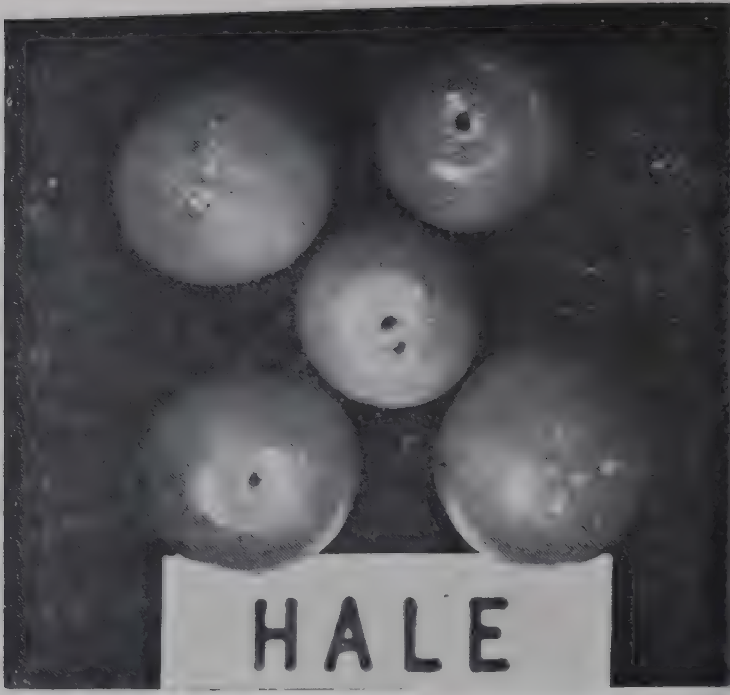
Without loss of time, the fruits were sorted, graded and divided in two lots which were stored at 32-35°F and 35-38°F with relative humidity (R.H.) of 85-90 per cent. These temperatures were selected, as in the literature,

Table I. *Cumulative physiological losses* in weight in plums during refrigerated storage*

Storage period	Gaviota		Hale		Shiro		Alu-Bokhara		Rubio	
	32-35°F	35-38°F	32-35°F	35-38°F	32-35°F	35-38°F	32-35°F	35-38°F	32-35°F	35-38°F
7 days	3.7	6.6	2.9	4.4	2.1	6.3	1.8	7.9	3.6	3.4
14 ,, ...	5.6	8.2	8.6	8.2	3.7	9.6	9.6	13.0	5.2	6.3
21 ,, ...	6.2	10.4	10.0	9.2	4.0	10.8	...	...	7.8	7.9
28 ,, ...	7.9	12.6	12.9	13.1	5.2	14.4	...	...	10.0	15.5

* Losses (%) due to respiration and transpiration.





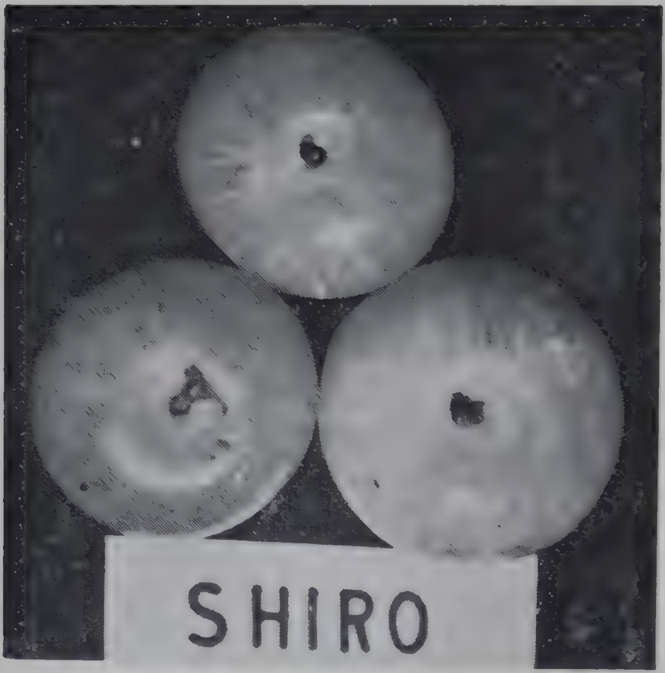


FIG. 1 (i—v)

Gaviota: Attractive wine colour, fine ashy bloom, yellow flesh, medium size.

Hale: Medium, round, dull red colour, pal yellow flesh, juicy and sweet when ripe.

Shiro: Large, slightly tapering at distal en with golden yellow colour and fine ashy bloom, flesh yellow, very juicy.

Alu-Bokhara: Medium, slightly elongated, yellow skin having red splashes, flesh white juicy, sub-acid in taste.

Rubio: Medium, round, crimson in colou with red juicy sub-acid flesh.

ALU-BOKHARA

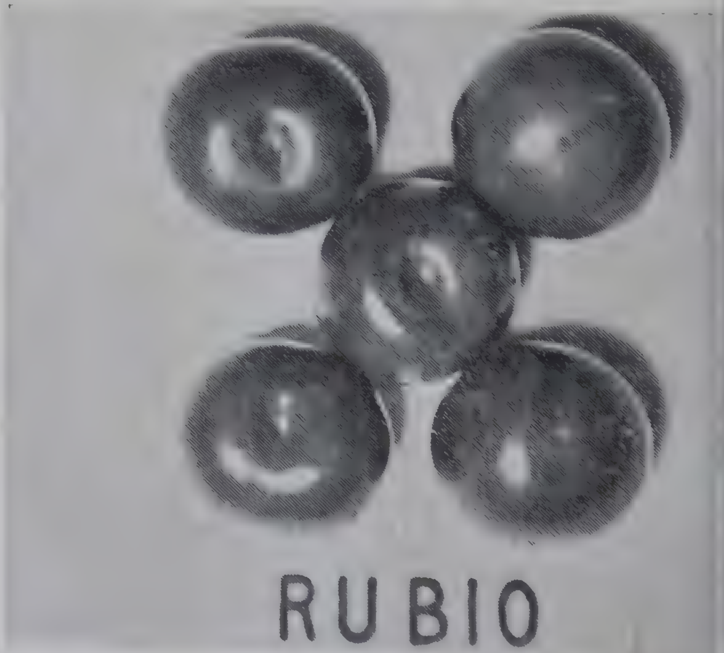


TABLE II. *Total soluble solids (Brix) in plums during refrigerated storage*

Storage temperature (°F) and R.H. 80-90%	Varieties	After storage period of (days)							
		Initial	4	8	12	16	20	24	28
32–35	Gaviota	8.0	12.0	12.5	13.5	14.0	15.0	15.0	17.0
	Hale	9.0	12.0	13.0	13.5	14.5	15.0	16.5	17.5
	Shiro	8.0	12.0	12.5	12.5	13.5	15.0	15.5	17.0
	Alu-Bokhara	8.0	12.0	13.0	13.0	14.0	...	...	...
	Rubio	8.0	12.0	12.5	13.0	13.5	14.0	...	...
35–38	Gaviota	8.0	12.0	12.0	13.0	14.5	15.0	...	...
	Hale	9.0	12.0	12.5	13.5	15.0	15.5	16.5	17.0
	Shiro	8.0	11.0	11.5	12.0	12.5	15.0	...	...
	Alu-Bokhara	8.0	12.0	13.0	13.5	14.0	...	...	...
	Rubio	8.0	12.0	13.0	13.5	13.5	14.5	...	...

TABLE III. *Acidity* in plums stored at 32-35°F. and 35-38°F. (R.H. 80-90%)*

Storage period	Gaviota		Hale		Shiro		Alu-Bokhara		Rubio	
	32-35°F	35-38°F	32-35°F	35-38°F	32-35°F	35-38°F	32-35°F	35-38°F	32-35°F	35-38°F
Initial	1.31	1.31	1.88	1.88	1.85	1.85	2.97	2.97	3.08	3.08
7 days	1.39	1.23	2.05	1.34	1.86	1.85	3.22	2.79	3.45	2.93
14 ,,	1.47	1.31	2.17	1.80	1.85	1.77	2.60	2.31	3.11	2.92
21 ,,	1.47	1.07	2.01	1.61	1.47	1.34	...	...	3.01	2.68
28 ,,	1.34	...	1.88	1.34	1.34	1.26	...	...	...	...

* In terms of per cent malic acid of edible portion.

it was found that plums cannot be stored for long period at higher temperatures. Each replication consisted of 200 fruits and were stored in well ventilated wooden crates. Respiration rates of the marked fruits were recorded at regular intervals by the continuous current method at 67-70°F. Respiration rate was expressed as mg. CO_2 per Kg. of fruit per hour. Similarly, cumulative physiological losses in weight were also recorded from the marked fruits. Changes in acidity, vitamin C and sugars, were estimated according to A.O.A.C. methods[9], at weekly intervals. Total soluble solids were determined by taking direct reading of the composite sample of fresh fruit juice, on a hand refractometer (Ziess Opton. No. 125147). The storage life was estimated based on ten per cent spoilage and general acceptability.

Results and Discussions

Table I gives the cumulative physiological losses in weight of all the five varieties of plums. It is evident that the losses are lower at 32-35°F as compared with those at 35-38°F. The changes in percentage total soluble solids, recorded in Table II, exhibit an increase during storage in all the varieties at both the temperatures. The changes in total acidity represented

TABLE IV. *Vitamin C during refrigerated storage of plums*
(Mg. of ascorbic acid/100 g. of edible portion)

Days after storage	Gaviota		Hale		Shiro		Alu-Bokhara		Rubio	
	32-35°F	35-38°F	32-35°F	35-38°F	32-35°F	35-38°F	32-35°F	35-38°F	32-35°F	35-38°F
Initial	3.5	3.5	4.5	4.5	2.5	2.5	3.0	3.0	4.4	4.4
7 days	3.0	3.4	3.4	3.4	1.7	2.1	2.1	2.1	3.8	3.1
14 ,, ...	0.9	2.0	2.1	2.1	2.1	2.0	2.1	2.1	3.4	3.0
21 ,, ...	0.5	0.9	0.9	0.9	0.9	0.9	—*	—*	1.7	1.7
28 ,, ...	Trace	—*	0.5	0.5	0.5	—*	—*	—*	—*	0.9

* Experiments closed due to wastage going above 10 per cent.

TABLE V. *Changes in sugars during refrigerated storage of plums*

Storage temperature (R.H. 80-90%)	Varieties	Initial values			Values (%) after storage for											
					7 days			14 days			21 days			28 days		
		RS	NRS	TS	RS	NRS	TS	RS	NRS	TS	RS	NRS	TS	RS	NRS	TS
32-35°F	Gaviota	1.90	5.21	7.11	2.15	5.17	7.31	3.41	5.15	8.56	4.28	4.65	8.93	8.28	3.16	11.44
	Hale	1.81	5.78	7.59	2.01	5.93	7.94	2.38	6.13	8.51	3.74	5.41	9.15	7.65	3.93	11.58
	Shiro	3.92	4.00	7.92	4.06	3.89	7.95	4.43	3.58	8.01	6.19	2.16	8.35	8.10	3.36	11.46
	Alu-Bokhara	4.83	1.49	6.32	5.02	3.34	8.36	5.11	0.52	5.63	...	...	...	...	...	...
	Rubio	5.12	1.44	6.56	5.32	1.63	6.95	6.52	1.16	7.67	8.21	1.08	9.29	...	...	...
35-38°F	Gaviota	1.90	5.21	7.11	3.45	4.37	7.83	4.43	3.62	8.05	4.97	4.52	9.49	...	...	...
	Hale	1.81	5.78	7.59	3.21	5.72	8.93	4.91	5.33	10.24	5.00	5.53	10.53	5.49	5.31	10.80
	Shiro	3.92	4.00	7.92	4.25	3.83	8.08	5.88	2.35	8.23	6.30	3.24	9.54	...	...	...
	Alu-Bokhara	4.83	1.49	6.32	5.21	3.29	8.50	4.10	0.52	4.62	...	...	...	...	...	...
	Rubio	5.12	1.44	6.56	6.19	2.00	7.19	6.78	1.37	8.15	7.65	1.17	8.82	...	...	...

RS =Reducing sugars. NRS = Non-reducing sugars. TS = Total sugars.

as malic acid per 100 g. of the edible portion of the fruit have been given in Table III. It is noticed that the acidity generally builds up in the initial stages of storage but decreases rather sharply at the end part of the storage period. At 32-35°F the acidity at the end of storage is almost the same as initially recorded *i.e.*, before storage, except in *Shiro* variety where it is slightly less than the initial. At 35-38°F, however, there is a little more decrease in the acidity at the end of storage period in all the varieties studied. Vitamin C values (Table IV) decrease during storage in the same pattern in all the five varieties but the decrease is less in fruits stored at 32-35°F than those stored at 35-38°F.

Changes in reducing, non-reducing and total sugars, are recorded in Table V. The reducing sugars (RS) increase during refrigerated storage at both temperatures in all the varieties. The non-reducing sugars (NRS) in *Gaviota* show a gradual decrease at 35-38°F, whereas at 32-35°F, it is steady upto 14 days and decreases afterwards. Similar results are obtained in *Hale* also, but in *Shiro* there is a regular decrease in NRS during storage at both the temperatures. In *Alu-Bokhara* and *Rubio* varieties, the NRS first increases and then decreases at both the temperatures. The total sugars increase in all the varieties during storage at both temperatures, but in *Alu-Bokhara* and *Rubio* varieties, the increase is the least. Both these varieties are acidic in nature.

The respiration curves (Fig. 2 i-v) show that the respiration rates are low at 32-35°F as compared to 35-38°F, except in *Gaviota*, where respiration rate is higher at 32-35°F, after 21 days. In some varieties, the tendency of attaining the peak value (climactric) is also seen.

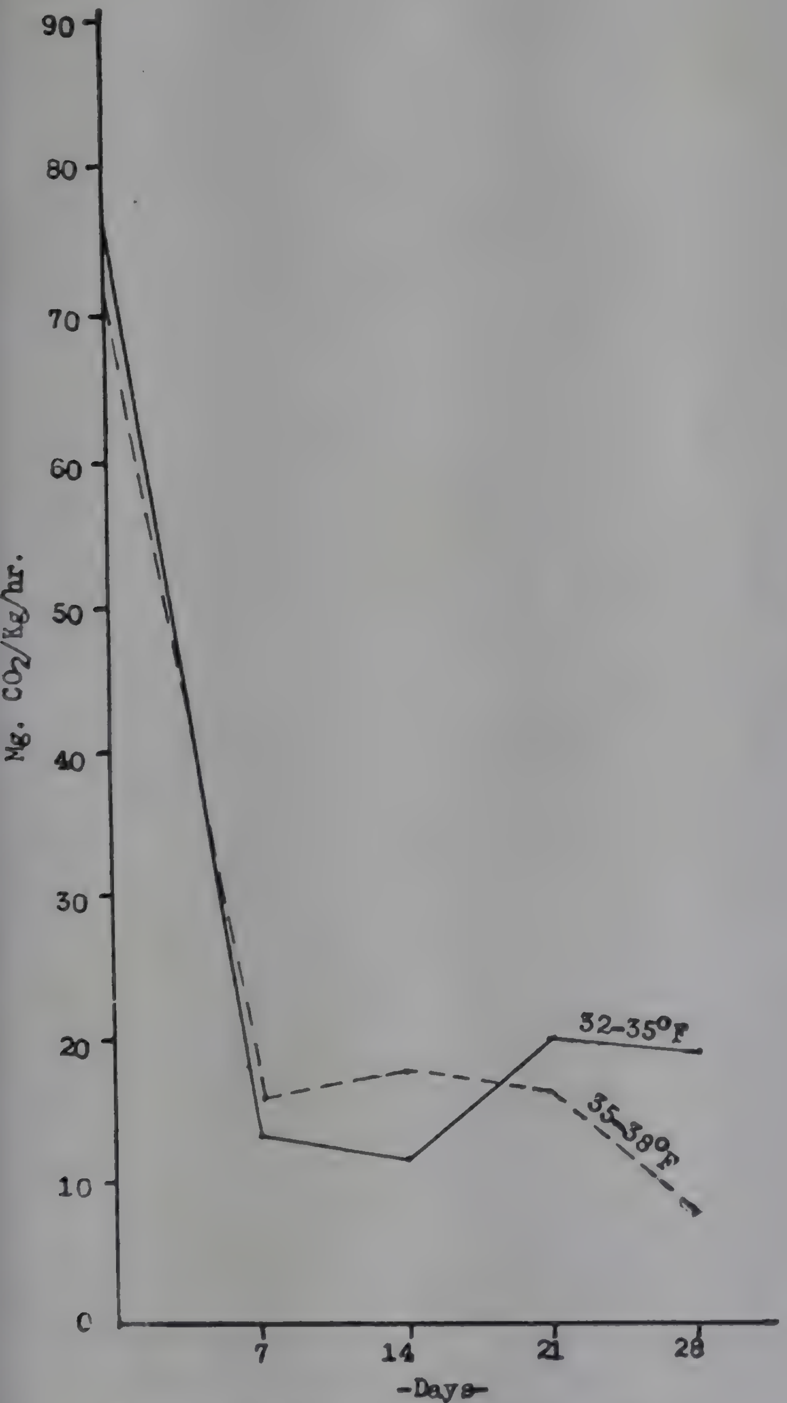


Fig. 2 (i) Respiration rate of *Gaviota* plums during storage

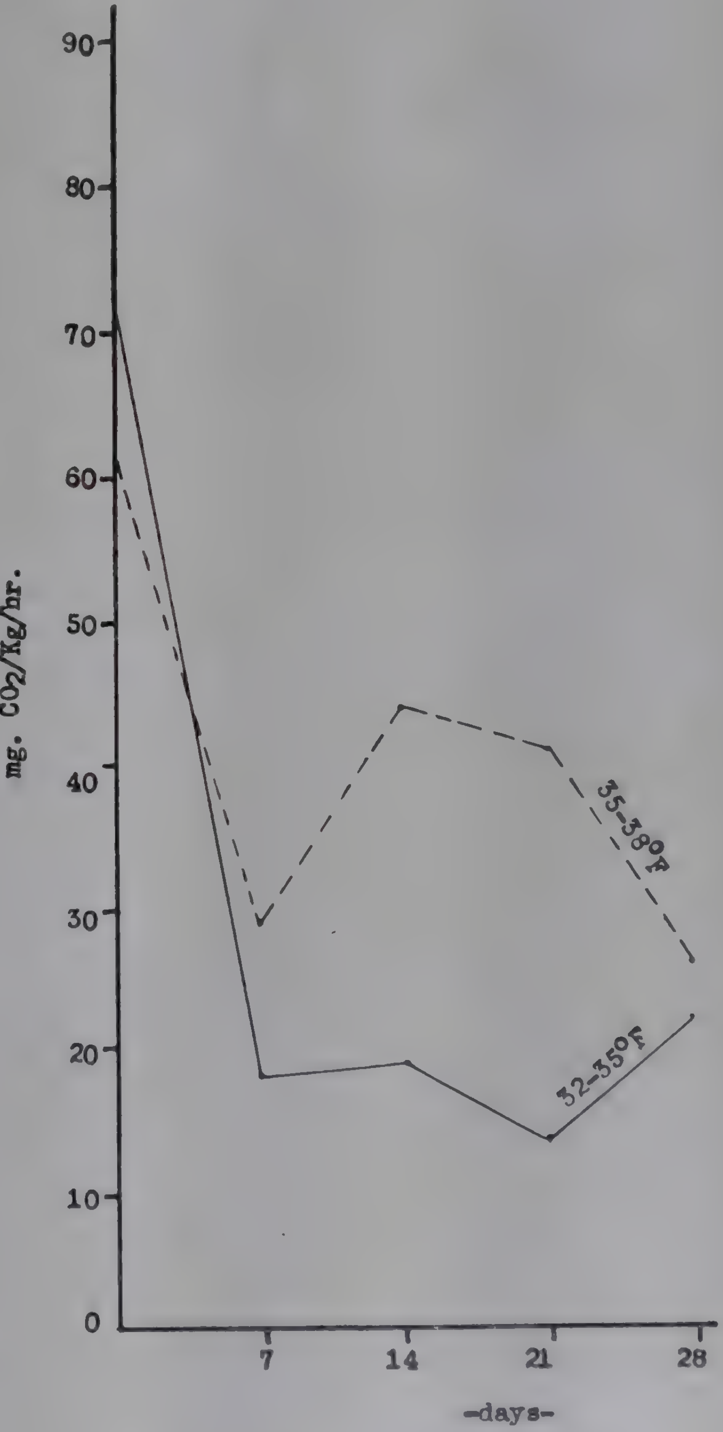


Fig. 2 (ii) Respiration rate of *Hale* plums during storage

Economic storage life: Wastage had been recorded at regular intervals and the experiment was closed as soon as the wastage went above 10 per cent level. Based on the wastage data, the economic storage life has been calculated and expressed as a histogram (Fig. 3). It can be seen that *Hale* and *Shiro* could be kept for 28 days, *Gaviota* for 24 days, *Rubio* for 20 days, and *Alu-Bokhara* for 12 days, at 32-35°F.

The nature of spoilage during storage covered internal browning, shrivelling and blue mould rot caused by *Penicillium* sp., which was more pronounced if held longer in cold storage. Brown rot caused by *Sclerotinia* sp. was not found. It was also observed that too much confidence could not be placed on the outer appearance of the cold stored fruit as sometimes, when the plums were held for longer periods and then removed to the room temperature, they tended to shrivel, decay and undergo internal breakdown within 24-48 hours of removal from the cold storage.

To study the post-storage behaviour, the plums after their normal refrigerated storage life were removed and kept at 68-70°F and 72-85°F, (room temperature). It was found that whereas at 68-70°F, they could easily be kept for 5 days,

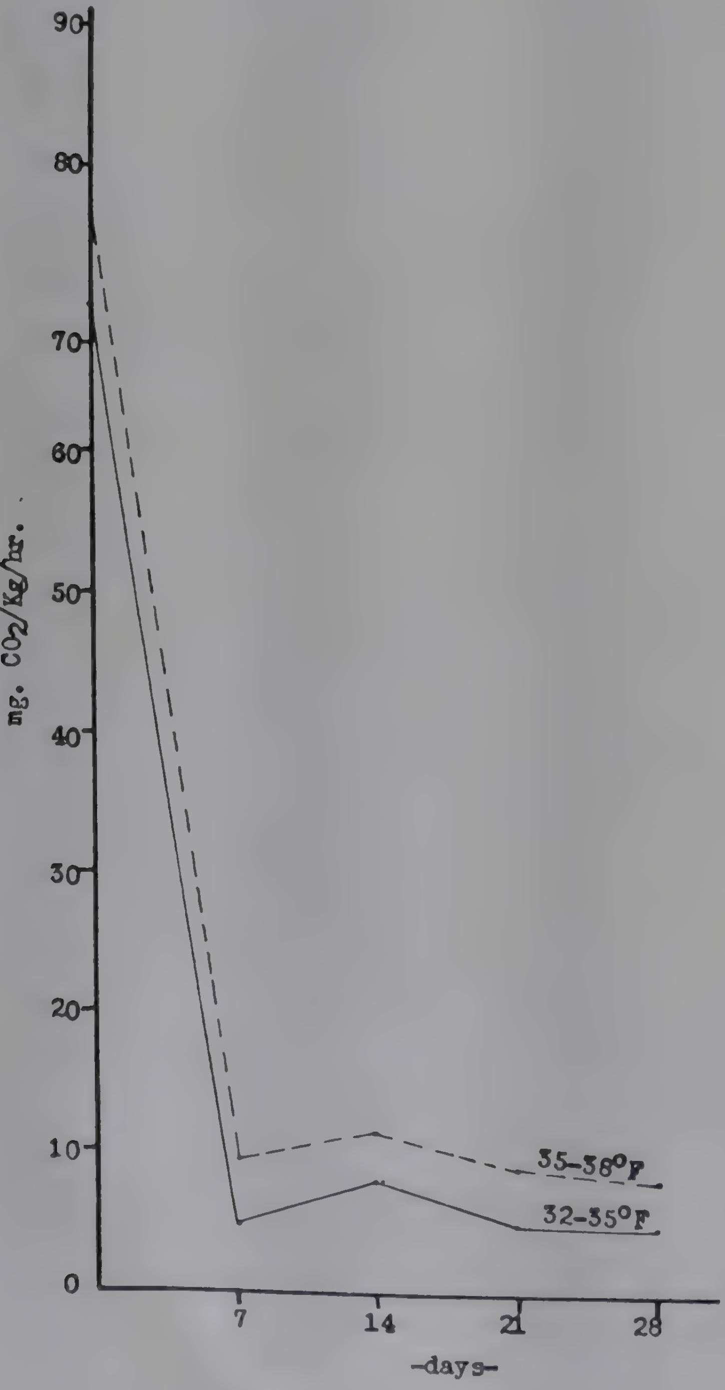


FIG. 2 (iii) Respiration rate of *Shiro* plums during storage

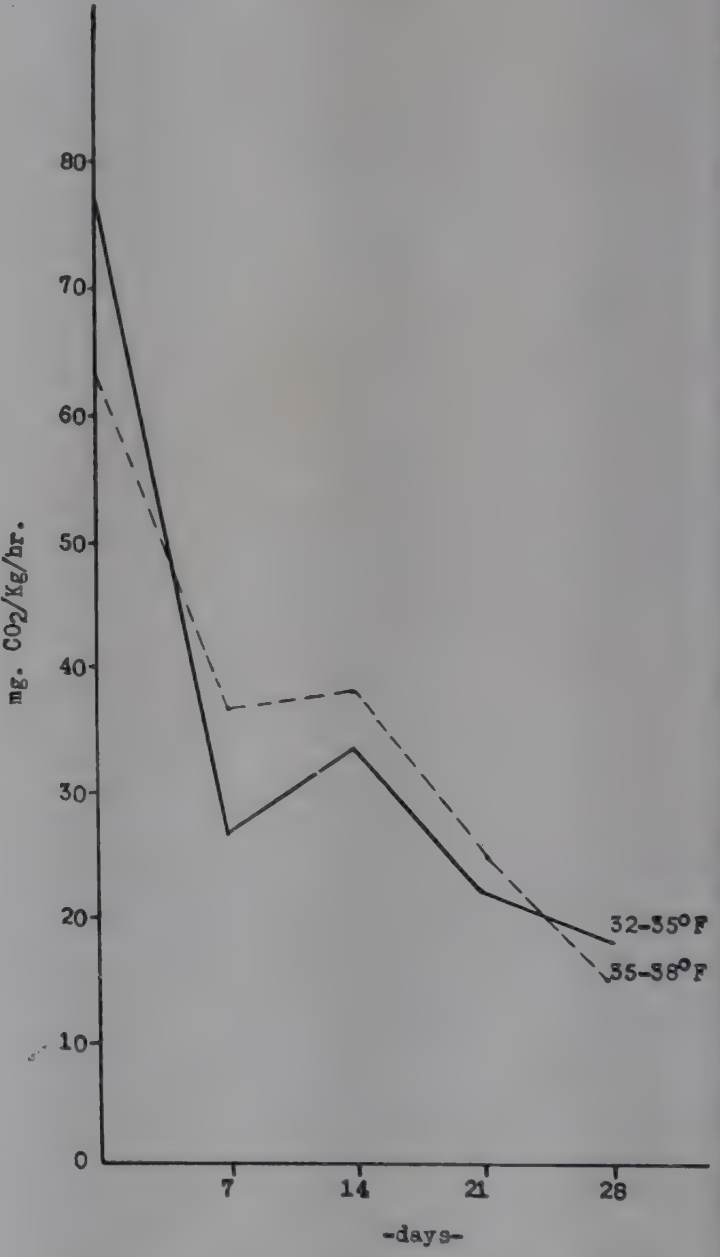


FIG. 2 (iv) Respiration rate of *Alu-Bokhara* plums during storage at the room temperature (72-85°F) they kept only for 2-3 days.

Summary

Five varieties of plums, *viz.*, *Gaviota*, *Shiro*, *Hale*, *Alu-Bokhara* and *Rubio* brought from Coonoor were used for investigations on their refrigerated storage behaviour. The physico-chemical changes during storage revealed that the physiological losses in weight were lower at 32-35°F than at 35-38°F and there was a steady increase in total soluble solids. There was a build-up of acidity in the beginning of storage period at 32-35°F. which decreased rather sharply at the end of storage period. Vitamin C decreased during storage at both the storage temperatures. The reducing sugars increased during storage, whereas non-reducing sugars in *Gaviota* and *Hale* remained constant in the beginning and decreased later on. In *Shiro*, there was regular decrease in non-reducing sugars throughout the storage. In *Alu-Bokhara* and *Rubio*, it increased during the first week but decreased later on. The total sugars in all the varieties at both the temperatures increased. The respiration rates of all the varieties were low at 32-35°F as compared to 35-38°F. A tendency of attaining the climacteric (peak points) was observed during storage. The storage life at 32-35°F based on organoleptic tests and wastage was as follows:

Hale and *Shiro*	28 days	*Rubio*	20 days
Gaviota	24 days	*Alu-Bokhara*	12 days

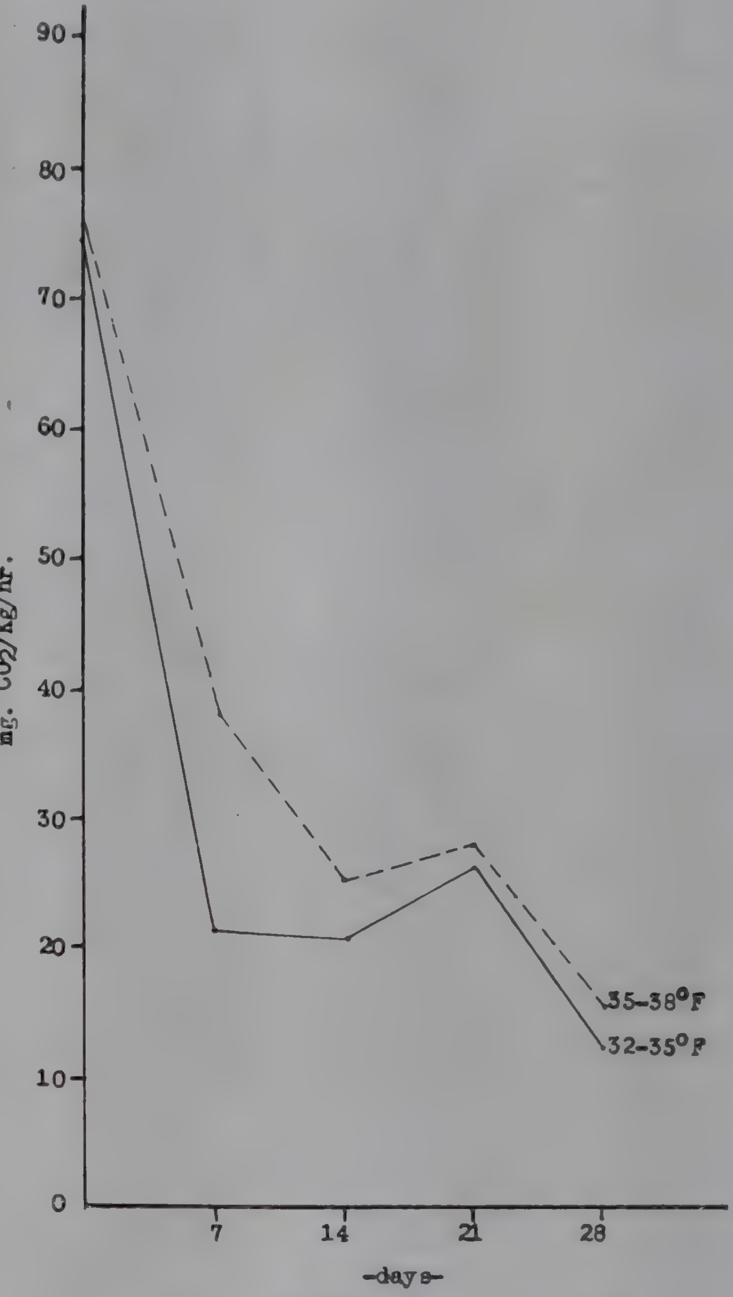


FIG. 2 (v) Respiration rate of *Rubio* plums during storage

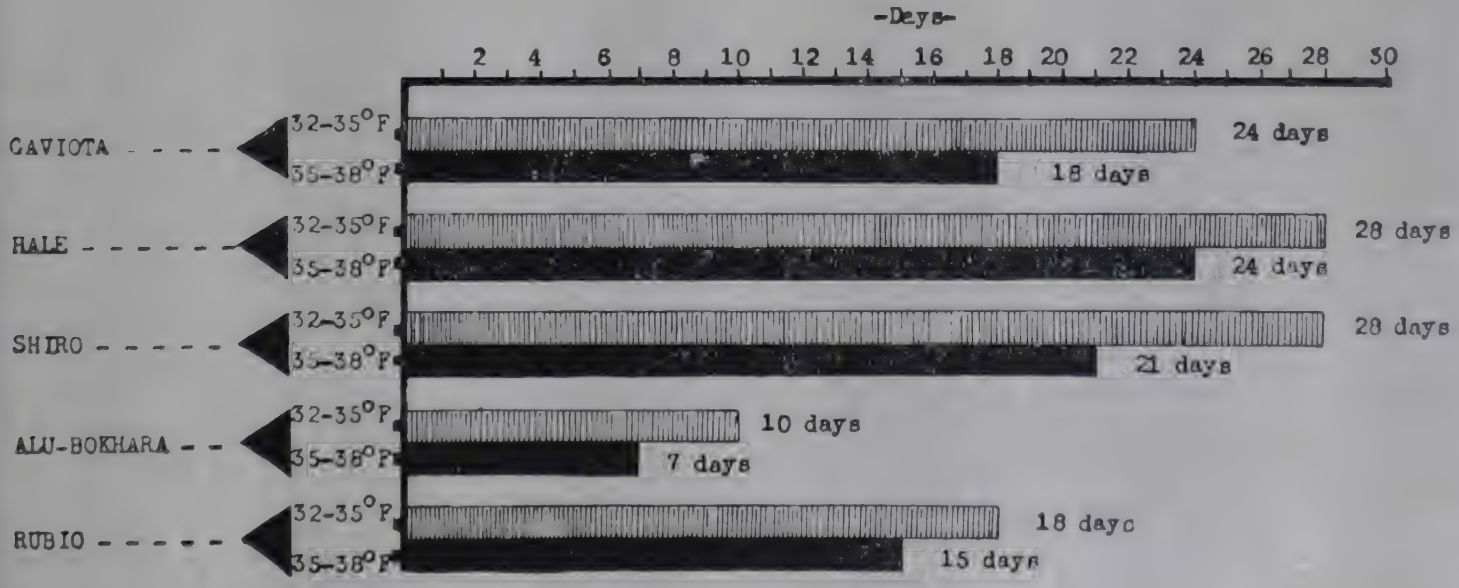


FIG. 3. Economic storage life of plums

The post-storage life at 68-70°F was 5 days and at 72-85°F (room temperature) 2-3 days.

Acknowledgment

The authors are grateful to Dr V. Subrahmanyan, Director and Dr A. Sreenivasan, Deputy Director for their interest in the investigation and helpful criticism.

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REFRIGERATED STORAGE OF MANGOSTEEN (*GARCINIA MANGOSTANIA*)

By H. C. Srivastava, K. Kripal Singh* and P. B. Mathur†

(*Central Food Technological Research Institute, Mysore*)

The mangosteen is generally regarded as one of the most delicious fruits of the East. However, the fruit is still very much restricted in its distribution. According to Spoon[1] a number of trial shipments of mangosteens were made during the years 1927-29 from Java to Holland. The fruits were carried at a temperature of 37.4°F and they remained in good condition for 24 days. Experimental shipments of Burma-grown mangosteens[2] to London have been made from 1929 onwards. A temperature of 48-54°F was found fairly satisfactory for transportation over a period of 33 days. The best fruits in respect of quality were those which had been picked when almost fully ripe. One of the main difficulties in the cold storage of mangosteens is the hardening of the rind which occurs with prolonged storage.

Material and Methods

The fruits for this investigation were obtained in two lots at an interval of two months from Kallar and Burliar fruit stations in Nilgiris. The first lot was stored at 32-35°F, 42-45°F and 52-55°F and the second one at 32-35°F, 35-38°F and 39-42°F. The fruits used for these investigations were almost in a fully ripe stage. The relative humidity in all the cold storage chambers ranged between 85 and 90 per cent. Total soluble solids were determined by means of refractometer. Reducing sugars were estimated in accordance with the Munson-Walker-Bertrand method[3]. For the estimation of acidity, fruit juice was titrated against N/10 sodium hydroxide solution. Ascorbic acid was estimated by direct titration of the juice against a standard solution of 2:6 dichlorophenol indophenol. Respiration measurements were also made on single marked fruits belonging to the second lot. The continuous current method was employed, the CO_2 evolved being absorbed in barium hydroxide solution which was subsequently titrated against standard hydrochloric acid.

Results and Discussion

The percentage physiological losses in weight in mangosteens during storage at various temperatures are recorded in Table I. The physiological losses in weight were found to be lower with decreasing storage temperatures.

The data regarding the chemical changes in mangosteens during storage at various temperatures are presented in Table II. A decrease in total soluble solids, an increase in reducing sugars, a decrease in total acidity and a decrease in ascorbic acid content were observed.

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* At present Fruit Specialist, Patiala.

† At present at the Biology Division, Atomic Energy Commission, Bombay.

TABLE I. *Physiological losses in weight of mangosteens stored at various temperatures*

Storage temperature (°F)	Original weight (g)	Percentage loss in weight, after (days)					
		14	28	42	56	70	84
Lot No. I							
32–35	98.2	3.5	6.9	10.1	13.9	17.3	...
42–45	105.7	3.6	6.9	10.3	14.3	17.5	...
52–55	106.5	4.6	9.2	16.1	26.4	40.4	...
Lot No. II							
32–35	82.1	6.5	10.1	17.3	21.2	25.9	29.6
35–38	83.8	7.2	10.3	17.9	24.0	27.7	31.2
39–42	77.3	8.0	13.5	19.1	25.1	...	...

TABLE II. *Chemical changes in mangosteens stored at various temperatures*

Storage temperature (°F)	Total soluble solids (% edible portion)		Reducing sugars (% edible portion)		Acidity*		Ascorbic acid (mg/100 g. edible portion)	
	Original	Final	Original	Final	Original	Final	Original	Final
Lot No. I								
32–35	18.8	16.0	2.7	10.0	11.1	8.2	8.0	1.0
42–45	18.8	14.0	2.7	9.6	11.1	5.2	8.0	1.2
52–55	18.8	...	2.7	...	11.1	...	8.0	1.6
Lot No. II								
32–35	20.5	19.5	2.8	14.5	11.8	10.6	8.2	0.0
35–38	20.5	19.5	2.8	15.5	11.8	9.0	8.2	2.0
39–42	20.5	19.5	2.8	8.0	11.8	7.9	8.2	2.8

* cc. N/10 NaOH used for 10 cc. juice.

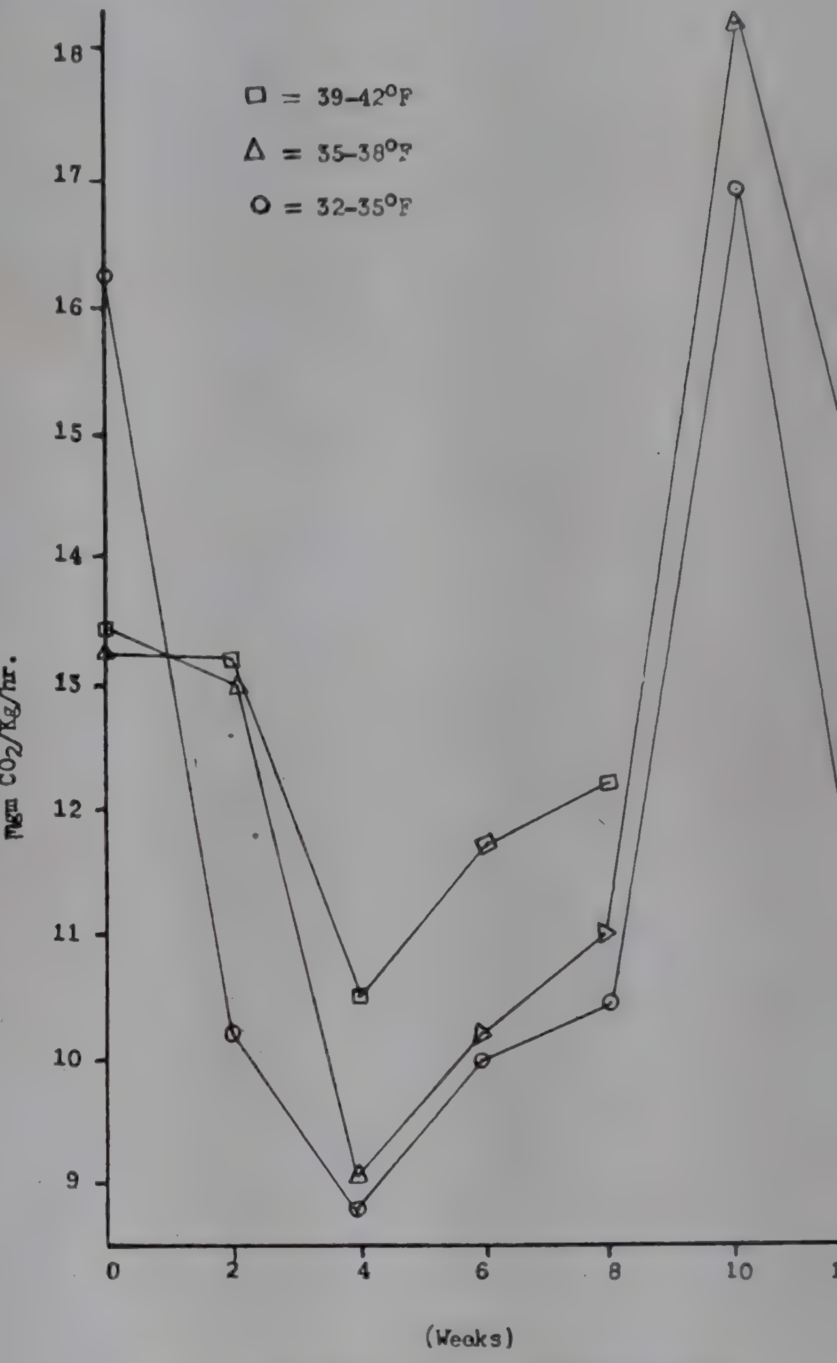

FIG. 1. Respiration rates of mangosteens stored at various temperatures

The data obtained with regard to the respiration rates are graphically shown in Fig. 1. The respiration rates in mangosteens were higher, the higher the storage temperature. In each case, the respiration rate dropped rapidly during a period of 28 days and was followed by the climactric rise. Observations with regard to the organoleptic evaluation of the fruits showed that from the point of view of external appearance and taste of the fruit the safe storage periods for this fruit are as follows:

32-35°F	63 days
35-38°F	56 days
39-42°F	49 days
42-45°F	42 days
52-55°F	35 days

But the hardening of the rind was found to be greater, the lower the storage temperature. As excessive hardening of the rind is likely to affect adversely the marketability of mangosteens, a temperature of 39-42°F (R.H. 85-90 per cent) is recommended as the optimum for the cold storage of this fruit.

Summary

Mangosteens were stored at various temperatures ranging from 32°F to 55°F and 85-90 per cent R.H. The physiological losses in weight were found to be lower, the lower the storage temperature. A decrease in total soluble solids, an increase in reducing sugars, a decrease in total acidity and a decrease in ascorbic acid content were observed. The respiration rates were found to be higher, the higher the storage temperature. At all the storage temperatures, the respiration rate dropped rapidly during a period of 28 days and was followed by the climactric rise. The optimum conditions for the cold storage of mangosteens are a temperature of 39-42°F and a R.H. of 85-90 per cent. The storage life is 49 days.

Acknowledgment

Authors' thanks are due to Dr V. Subrahmanyan for his keen interest in these investigations.

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REFRIGERATED GAS STORAGE OF MANGOES

By N. S. Kapur, K. Sarveshwara Rao and H. C. Srivastava

(Central Food Technological Research Institute, Mysore)

The storage of commodities under an atmosphere of low O_2, high CO_2 or both, at room temperature (RT) or at optimum low temperature can be termed as gas storage. Most of the investigations[1] so far carried out in this field confine to apples and pears. Banerjee, *et al*[2] did not find any significant increase in storage life of mangoes under 5 to 20 per cent CO_2 atmosphere. Singh[3] reported CO_2 output of mature mangoes being minimum under 9.2 per cent O_2 atmosphere (R.Q. 0.85) and suggested the possibility of extension of senescent ripening period. This paper deals with the systematic refrigerated gas storage of two varieties of mangoes.

Experimental

Fully mature, firm and green *Alphonso* and *Raspuri* mangoes were harvested in a nearby orchard and brought to the laboratory. They were sorted and immediately placed in airtight containers equipped with corks on the sides which could be adjusted to acquire the gas atmosphere as per requirements. The fruits were allowed to respire and build up CO_2 atmosphere. It took 4 days to build up 5 per cent CO_2, 5 days to 7.5 per cent and 6 days to 10 per cent CO_2 level. As soon as the required level was attained in the container, corks were carefully opened, so that the exact composition of CO_2 was maintained. The *Alphonso* mangoes were stored at 47-50°F and the *Raspuri* at 42-45°F[4]. Changes in acidity, ascorbic acid, total soluble solids, physiological loss in weight, respiration and fruit pressure were recorded at weekly intervals. Methods of analysis are indicated below the respective tables.

Results and Discussion

In Table I, the fruit pressure has been recorded. Fruit pressure in all cases remained more than 30 for the first 21 days. It then decreased to 14 after 35 days in case of *Alphonso* mangoes in the control lot and to 23, 24 and 26 respectively in lots stored under atmospheres of 5.0, 7.5 and 10 per cent CO_2. In case of *Raspuri* mangoes also the fruit pressure was higher in gas stored than in the control. It is noted that at the end of storage period, fruit pressure was

TABLE I. *Fruit pressure in refrigerated gas storage of mangoes*
(Initial 30 lbs/sq. inch)

Sl. No.	Treatment	*Badami (Alphonso)*					*Raspuri*						
		After days					After days						
		7	14	21	28	35	7	14	21	28	35	42	49
1	Control	30	30	30	17	14	30	30	30	30	25.5	20	15
2	5.0 % CO_2	30	30	30	26	23	30	30	30	27.5	28.0	25	21
3	7.5 % CO_2	30	30	30	27	24	30	30	30	26.7	28.0	25	22
4	10.0 % CO_2	30	30	30	25	20	30	30	30	27.5	25.5	20	18.5

TABLE II. *Percentage physiological loss in weight in mangoes*

Sl. No.	Treatment	*Badami (Alphonso)*					*Raspuri*						
		After days					After days						
		7	14	21	28	35	7	14	21	28	35	42	49
1	Control	0.95	2.12	5.75	7.35	10.25	1.2	2.4	3.6	4.7	6.2	7.0	7.8
2	5.0% CO_2	0.41	0.75	1.06	2.27	3.23	0.6	0.7	1.1	1.2	1.8	2.1	2.5
3	7.5% CO_2	0.42	0.25	1.26	1.87	2.25	0.2	6.6	1.02	1.1	1.3	1.6	1.8
4	10.0% CO_2	0.05	0.1	0 6	1.12	1.62	0.06	0.2	0.7	0.6	1.1	1.2	1.2

TABLE III. *Changes in ascorbic acid* during refrigerated gas storage of mangoes*

Sl. No.	Treatment	*Badami (Alphonso)* Initial : 125.3 mg/100 g.					*Raspuri* Initial : 47.6 mg/100 g.						
		After days					After days						
		7	14	21	28	35	7	14	21	28	35	42	49
1	Control	87.9	64.3	48.3	34.0	20.1	42.2	40.4	37.4	34.4	27.4	18.6	17.2
2	5.0% CO_2	92.4	73.0	55.9	46.0	32.9	46.4	41.8	39.7	36.2	35.1	30.4	27.4
3	7.5% CO_2	100.3	92.1	73.5	58.9	45.2	42.9	40.8	37.9	35.1	32.4	28.6	27.4
4	10.0% CO_2	113.8	105.0	88.0	68.2	51.6	45.2	42.8	40.1	38.9	36.6	25.1	22.8

* Estimated by titration against a standard solution of 2: 6 dichlorophenol indophenol.

maximum at 5.0 and 7.5 per cent CO_2 atmosphere. The physiological loss in weight in gas stored fruits was much less than that in the control, value being 7 to 10 per cent in the two varieties in the control as against 1.2 to 1.6 per cent in the gas stored ones, (Table II). Changes in ascorbic acid content of variously treated mangoes (Table III) showed a continuous decrease during storage. The rate of decrease was less in the gas-stored ones than in the control. As the concentration

TABLE IV. *Changes in acidity* in refrigerated gas storage of mangoes*

Sl. No.	Treatment	*Badami (Alphonso)* Initial: 3.83%					*Raspuri* Initial: 6.73%						
		After days					After days						
		7	14	21	28	35	7	14	21	28	35	42	49
1	Control	3.20	2.06	1.20	0.90	0.59	5.48	4.09	3.41	2.15	1.81	1.61	1.01
2	5.0% CO_2	3.11	2.52	2.06	1.23	1.16	6.10	4.02	3.95	2.81	2.01	1.87	1.48
3	7.5% CO_2	3.31	2.85	2.56	1.88	1.57	6.21	4.35	3.74	2.81	2.28	1.81	1.88
4	10.0% CO_2	3.63	3.10	2.76	2.51	2.04	6.35	4.68	3.74	2.47	2.88	2.08	1.68

* Estimated by titrating against standard NaOH solution and expressed as per cent citric acid.

TABLE V. *Changes in total soluble solids during refrigerated gas storage of mangoes*

Sl. No.	Treatment	*Badami (Alphonso)* Initial = 3.6					*Raspuri* Initial = 3.5						
		After days					After days						
		7	14	21	28	35	7	14	21	28	35	42	49
1	Control	8.5	12.5	13.0	15.0	16.0	8	8.6	12.5	12.5	13.0	14.0	15.0
2	5.0% CO_2	9.0	13.0	14.5	16.0	17.5	9	9.5	11.0	14.5	15.7	16.0	16.0
3	7.5% CO_2	9.5	13.5	15.0	17.5	18.5	7	11.5	12.0	14.0	15.0	16.0	16.0
4	10.0% CO_2	10.5	12.5	14.0	15.0	18.0	9.5	9.5	12.5	13.0	14.3	15.0	15.5

Estimated by taking a drop of the juice on hand refractometer.

TABLE VI. *Percentage wastage*

Sl. No.	Treatment	*Badami (Alphonso)*					*Raspuri*						
		After days					After days						
		7	14	21	28	35	7	14	21	28	35	42	49
1	Control	Nil	Nil	5%	10%	23%	Nil	Nil	Nil	2%	8%	10%	20%
2	5.0% CO_2	Nil	Nil	Nil	8%	15%	Nil	Nil	Nil	Nil	5%	9%	18%
3	7.5% CO_2	Nil	Nil	Nil	5%	9%	Nil	Nil	Nil	Nil	Nil	6%	8%
4	10.0% CO_2	Nil	Nil	2%	10%	20%	Nil	Nil	40%	6%	10%	13%	20%

of the CO_2 increases, the loss in ascorbic acid decreases in both the varieties of mangoes but in case of *Raspuri* mangoes, there is more loss in 10 per cent CO_2 atmosphere than in the 5.0 and 7.5 per cent CO_2.

The acidity expressed as percentage of citric acid in mangoes on the edible fresh weight basis has been recorded in Table IV. The acidity constantly decreases with the increasing storage time. The loss of acidity was more in the control (in both varieties) than in the gas stored fruits. There was more loss in the 5 per cent and 10 per cent CO_2 level in the case of *Raspuri* than at 7.5 per cent CO_2 level, but in case of *Alphonso* the least loss was at 10 per cent level. In Table V, the changes in total soluble solids in both varieties of mangoes have been recorded. The total soluble solids continuously increased in all cases and there seems to be insignificant difference among various treatments. This shows that storage under CO_2 atmosphere does not impair the quality of the fruits. In Table VI, the percentage wastage in fruits during refrigerated gas storage has been recorded. The wastage exceeded 10 per cent level in both *Raspuri* and *Alphonso* mangoes among all the treatments except those stored under 7.5 per cent CO_2 atmosphere. The respiration rate of mangoes first decreases, then increases, and again falls till the end of the storage period. The overall rate of respiration is less in the case of gas-stored fruits than the controls. The trends are presented in Fig. 1 and 2.

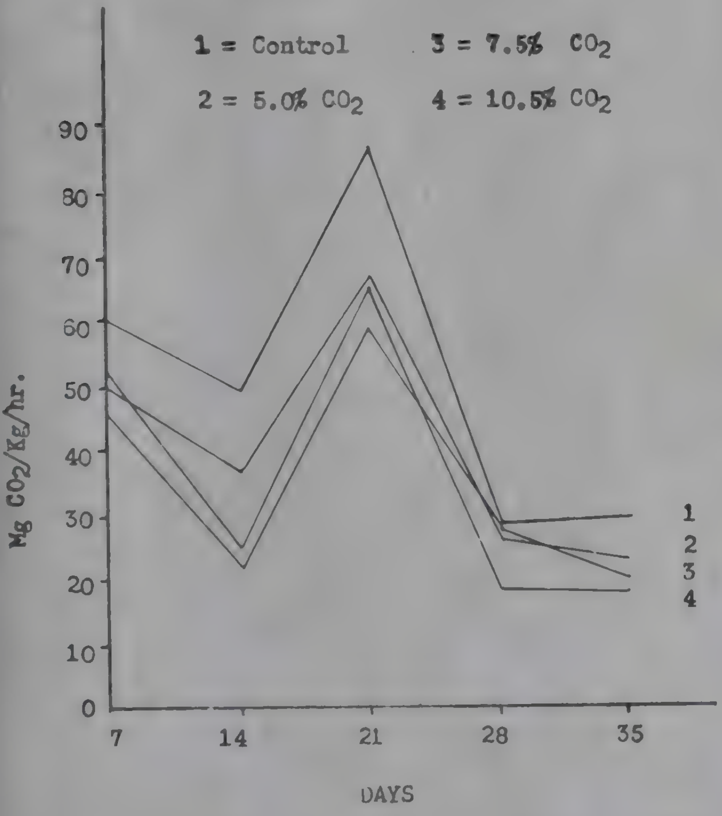

FIG. 1. Respiration rates of *Alphonso* mangoes stored under various atmospheres at 47-50°F

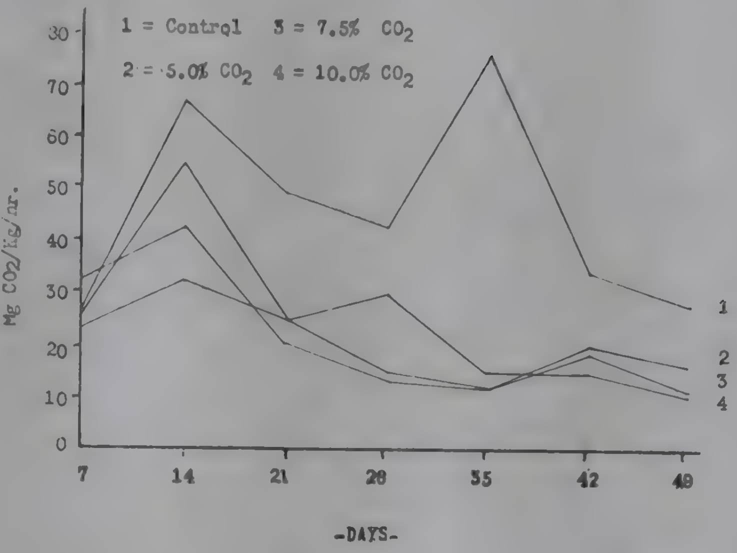

FIG. 2. Respiration rates of *Raspuri* mangoes stored under various atmospheres at 42-45°F

Conclusions

Mangoes can be stored in refrigerated gas storage for 35 days (*Alphonso*) at 47-50°F and 49 days (*Raspuri*) at 42-45°F within 10 per cent wastage level. The fruits ripen in 3 days satisfactorily. Fruit pressure, physiological loss in weight changes in acidity, ascorbic acid, T.S.S., percentage wastage and respiration rates were recorded at regular intervals and showed that refrigerated gas storage of mangoes, with restricted ventilation does not impair the quality of the fruit, while extending the storage life.

Acknowledgment

Grateful acknowledgment is made to Dr V. Subrahmanyan, Director and Dr A. Sreenivasan, Deputy Director, for their keen interest in the work.

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WAX EMULSION FOR EXTENDING THE STORAGE LIFE OF *SATHGUDI* ORANGES

By V. B. Dalal, S. D'Souza, H. Subramanyam and H. C. Srivastava

(Central Food Technological Research Institute, Mysore)

India occupies sixth place among the citrus-growing countries of the world and at present has over 2,54,641 acres under cultivation, with an estimated annual production of 3,37,200 tons of citrus fruits. Of this, over 40,000 tons are accounted for by *Sathgudi* oranges which are grown chiefly in the western and southern parts of the country[1]. The fruit suffers heavy losses from spoilage during handling, transportation and storage. An economical and acceptable method of treatment of these fruits has been developed at this Institute in order to avoid enormous wastage and to improve the marketability of fruits. This involves the application of a wax emulsion to the fruits whereby their storage life is considerably extended by reducing respiration and transpiration.

Miller[2], Minz[3], Boeke[4] and Hopkins and McCornack[5] have reported successful uses of waxes in prolonging the storage life of oranges. Sharma[6] developed a fungicidal wax coating and reported its commercial application in extending the storage life of fruits and vegetables. Mathur and Srivastava[7], Mathur and Subramanyam[8], Srivastava and Mathur[9] and Srivastava *et al.*,[10, 11] established the importance of waxing as a means to prolong the storage life of perishables.

This paper gives the results of the investigation undertaken to develop an aqueous wax emulsion containing natural indigenous ingredients and to study the effects of its application on *Sathgudi* oranges.

Materials and Methods

Fully mature fruits were brought from Madras and were sorted, graded and divided into four lots of three hundred each. Three of these lots were treated (within 3 days from the date of harvest) with aqueous fungicidal wax emulsion containing 3, 6 and 9 per cent solids respectively and one lot was kept as control. It was found in earlier experiments that application of over 9 per cent wax emulsion caused physiological breakdown in the fruits stored at room temperature. The composition of the wax emulsion was as follows:

Carnauba wax:	26 parts
Refined sugarcane wax, (Walchandnagar):	13 parts
Oleic acid:	5 parts
Triethanolamine:	6 parts
Refined bleached lac:	40 parts
(Lac Research Institute) and liquor ammonia:	10 parts

0.5 per cent sodium orthophenylphenate was added as a fungicide to all the three concentrations of the wax emulsion used.

The procedure of treatment adopted was: The fruits were dipped in the fungicidal wax emulsion for one minute, drained and dried with the help of an electric fan. All the lots were then stored at room temperature (75-92°F; 40-70 per cent R.H.) and observations were made at regular intervals of four days. Juice percentage, acidity and vitamin C (by dye titration) were estimated according to A.O.A.C. methods[12]. Total and reducing sugars have been estimated by modified Somogyi's method[13]. The respiration rate was measured by continuous current method at R.T. and expressed as mg. CO_2/kg/hr. The quality assessment of fruits, after storage, was carried out by a panel of judges with reference to colour, texture, taste and flavour. The order of preference was determined on the basis of points scored by fruits in each treatment.

Results and Discussions

The results obtained are presented in Tables I-IV and Figs. 1 and 2. The physiological losses in weight in *Sathgudi* oranges during storage at R.T. were found to decrease with treatment containing increasing quantities of wax (Table I).

It will be seen from Tables II and III that the total soluble solids (T.S.S.) increase and the acidity decreases during storage at room temperature. Since increase in T.S.S. and

TABLE I. *Cumulative physiological losses* in weight in Sathgudi oranges during storage at R.T.*

Treatment	Mean wt. of single fruit (g)	% Physiological losses in weight (after days) 4	8	12	16	20	24	28
Control ...	262	3.8	7.3	10.2	13.4	16.8	19.0	22.4
W.E. 3% ...	260	2.8	4.9	6.9	8.6	10.2	13.4	16.2
W.E. 6% ...	229	2.7	4.8	6.4	8.2	10.0	13.1	16.0
W.E. 9% ...	243	2.6	4.6	6.2	7.8	9.6	12.8	15.6

* Due to respiration and transpiration.
W.E. = Wax emulsion.

TABLE II. *Changes in T.S.S., juice and vitamin C in fruits during storage at R.T.*

Storage after days	% Juice				% T.S.S. in juice				Vitamin C mg/100 ml juice			
	Control	% wax emulsion			Control	% wax emulsion			Control	% wax emulsion		
		3	6	9		3	6	9		3	6	9
Initial	50.8	50.8	50.8	50.8	7.5	7.5	7.5	7.5	54.6	54.6	54.6	54.6
4	47.2	48.5	49.0	49.0	9.0	8.5	8.5	8.5	51.7	52.6	53.6	53.6
8	45.0	46.7	47.9	48.1	10.0	9.0	9.0	9.0	50.8	51.7	52.7	52.7
12	44.6	45.0	46.8	47.4	10.0	9.5	9.5	9.0	48.7	50.0	51.0	51.7
16	41.6	44.6	45.0	45.5	10.0	9.5	9.5	9.0	47.8	48.9	49.7	50.0
20	40.7	43.5	44.2	44.8	10.0	9.5	9.5	9.5	42.9	47.8	48.0	48.7
24	39.8	42.5	43.2	43.5	10.5	10.0	9.5	9.5	41.0	45.9	46.8	47.8
28	38.1	41.6	42.5	42.7	10.5	10.0	10.0	9.5	40.9	42.0	45.4	45.5

decrease in acidity are known to be associated with oranges during storage, the data presented in Tables II and III indicate that the treatment with increasing concentration of the wax emulsion has the progressively delaying effect on the reduction of acidity and increase in T.S.S. Moreover, treatment with increasing concentration of wax emulsion resulted in greater retention of vitamin C and juice in oranges during storage at room temperature. The reducing and non-reducing sugars increase during storage at R.T. (Table III). However, the build up of total sugars at the end of 28 days of storage in waxed fruits was less than in unwaxed fruits.

The respiration rates (Fig. 1) recorded at periodical intervals show that the rate of CO_2 production is less in treated fruits as compared to controls. The rate of respiration decreases with the treatments having increasing concentration of the wax emulsion. This may be attributed to wider coverage of surface area of the fruits by wax particles when higher concentration of the wax emulsion is used.

The wastage percentage due to diseases has been plotted in Fig. 2. There was 10 per cent wastage due to diseases among fruits treated with 6 and 9 per cent wax emulsion as against 26.5 per cent in untreated ones in 32 days of storage. On 10 per cent wastage basis, the storage life of the variously treated oranges stored at R.T. are: (*i*) control 13 days, (*ii*) 3 per cent wax emulsion 24 days (*iii*) 6 per cent wax emulsion 32 days and (*iv*) 9 per cent wax emulsion 32 days.

Marketability, dessication and quality assessment of waxed and unwaxed fruits are presented in Table IV. After 32 days of storage at room temperature, only 11 per cent of unwaxed fruits were marketable as against 90 per cent of fruits coated with 6 and 9 per cent wax emulsion.

TABLE III. *Changes in acidity and sugars during storage at R.T.*

Storage after days	Percentage total acidity expressed as anhydrous citric acid				Percentage sugar content											
	Control	% wax emulsion			Control			3% wax emulsion			6% wax emulsion			9% wax emulsion		
		3	6	9	RS	NRS	TS	RS	NRS	TS	RS	NRS	TS	RS	NRS	TS
Initial	0.35	0.35	0.35	0.35	1.73	4.20	5.93	1.73	4.20	5.93	1.73	4.20	5.92	1.73	4.20	5.92
4	0.33	0.34	0.34	0.35	2.62	5.16	7.78	2.26	5.06	7.68	2.62	5.16	7.78	2.43	4.64	7.07
8	0.31	0.33	0.34	0.34	3.01	5.80	8.81	2.80	5.50	8.30	2.80	5.90	8.70	2.69	5.60	8.29
12	0.31	0.31	0.34	0.33	2.90	5.99	8.89	3.46	5.48	8.93	3.46	5.38	8.83	3.39	4.93	8.33
16	0.29	0.30	0.32	0.32	3.71	5.34	9.05	3.58	5.36	8.94	3.58	5.36	8.94	3.00	5.35	8.35
20	0.28	0.29	0.31	0.31	3.82	5.70	9.52	3.01	5.90	8.91	3.55	5.40	8.95	2.80	5.70	8.50
24	0.28	0.29	0.30	0.31	3.26	6.67	9.93	3.50	5.40	8.90	3.07	6.35	9.42	3.20	5.53	8.73
28	0.28	0.28	0.29	0.30	4.03	6.04	10.07	3.20	6.02	9.22	3.26	6.37	9.63	3.39	5.45	8.84

RS = Reducing sugars. NRS = Non-reducing sugars. TS = Total sugars.

TABLE IV. *Quality assessment in terms of marketability,* dessication and order of preference of treated and untreated fruits during storage at R.T.*

Treatment	% Marketability* after days			% Dessicated after days			Quality assessment after a storage period of 32 days			
	16	24	32	16	24	32	Colour	Texture	Taste	Flavour
Control	88.5	49	11	0	33	62.5	Bad	V. bad	Flat	Poor
W.E. 3%	93.5	90	81.5	0	0	3	Good	Good	Good	Good
W.E. 6%	96.5	93	89.5	0	0	0	Good	V. good	V. good	V. good
W.E. 9%	96.5	93.5	90.0	0	0	0	Good	Good	Good	Good

* Based on gloss, firm texture and taste. W.E. = Wax emulsion.

The waxed fruits were good in colour, texture, taste and flavour at the end of the storage period.

From the foregoing it can be concluded that fungicidal wax coating technique as standardised at this Institute reduces the microbial and physiological spoilage, extends the storage life and improves the marketability of *Sathgudi* oranges. Fruits treated with 6 per cent wax emulsion were better in quality and marketability as compared to fruits treated with 3 per cent wax emulsion. It is further noted that among controls the wastage due to diseases exceeded 10 per cent after 13 days of storage while dessication started after 20 days. There was no marked difference in dessication and wastage in fruits coated with 6 and 9 per cent wax emulsion at the end of 32 days of storage. Thus from the point of view of storage, economic use of chemicals and consumer acceptability, fruits coated with 6 per cent wax emulsion were found to be the best of all the treatments.

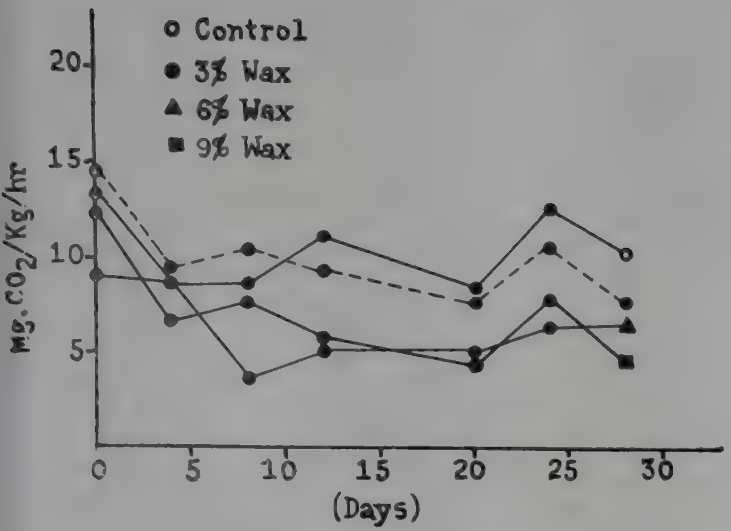

FIG. 1. Respiration rate of variously treated *sathgudi* oranges

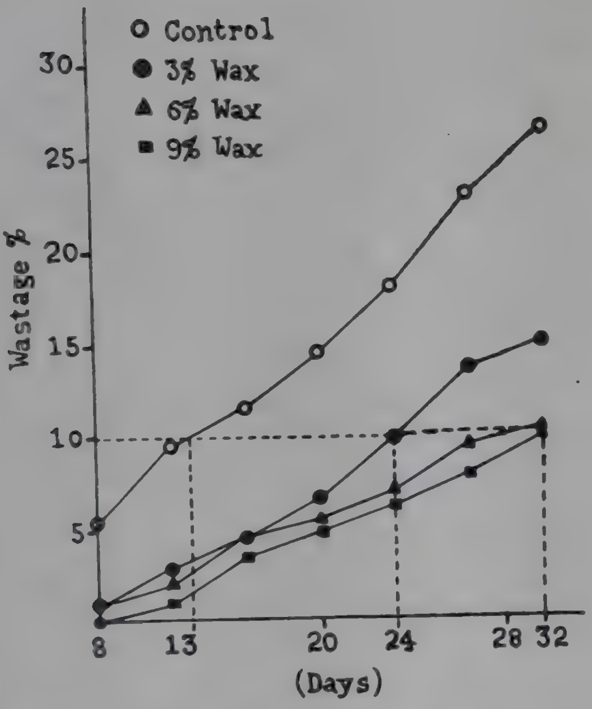

FIG. 2. Wastage % in variously treated *sathgudi* oranges

Summary

A suitable aqueous wax emulsion containing most of the ingredients from indigenous resources has been developed. This wax emulsion formula contains: carnauba wax 26 parts, refined sugarcane wax (Walchandnagar) 13 parts, oleic acid 5 parts, triethanolamine 6 parts, refined bleached lac (Lac Research Institute) 40 parts and liquor ammonia 10 parts. The wax emulsion when used in 6 per cent concentration containing 0.5 per cent sodium orthophenyl phenate as an instant dip for oranges, has doubled the storage life, reduced the wastage and improved marketability.

Acknowledgment

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EFFECT OF A FUNGICIDAL WAX COATING WITH OR WITHOUT GROWTH REGULATOR ON THE STORAGE BEHAVIOUR OF MANGOES

By H. Subramanyam, N. V. N. Moorthy, V. B. Dalal and H. C. Srivastava

(Central Food Technological Research Institute, Mysore)

Recent work has shown that skin coating of mangoes (*Alphonso*) with an aqueous fungicidal wax emulsion, increased the storage life of fruits by reducing wastage, delaying ripening and lowering respiration rates[1,2]. The colour development was also controlled by treating fruits in an aqueous solution of growth regulators[3-8]. In the present investigation the effects of fungicidal wax coating with or without growth regulator like maleic hydrazide (sodium salt of 1, 2-dihydropyridazine 3, 6-dione) and 2, 4-dichlorophenoxy acetic acid on the storage behaviour of *Badami* mangoes during storage at room temperature (R.T.) have been studied.

Experimental

The fruits for this investigation (picked from an orchard ten miles away from Mysore) were fully grown and olive green corresponding to the maturity stage B of Cheema and Dani[9] and stage 2 of Wardlaw and Leonard[10]. On the next day of their arrival in the laboratory, they were divided into four lots of 300 fruits each.

One lot was treated with an aqueous fungicidal wax emulsion containing 6 per cent solids and 1 per cent sodium-ortho phenyl phenate, a fungicide[11,12]. Second and third lots were treated in a similar fungicidal wax emulsion containing 250 p.p.m. of maleic hydrazide (MH) and 20 ppm of 2, 4-D respectively, and the fourth lot was used as the control. The fruits were dipped in the wax emulsion for one minute, drained and dried in a current of hot air (temp. 100-125°F) for 3-4 minutes. Each lot was further divided into six sub-lots of 50 fruits each and stored at room temperature (79-86°F and 55-78 per cent R.H.). The concentration of growth regulators used here in wax emulsion was reported as optimum effective concentration for delaying ripening in mangoes[3] and banana[13].

The fruits after various periods of storage were analysed by methods indicated under the tables of results.

Results and Discussion

The results obtained are shown in Tables I-VIII and Fig. 1. There was significant differ- ence in physiological losses in weight between treated and untreated lots, but there was no difference between various treatments (Table I), The growth regulators used in the given concen- tration in fungicidal wax emulsion did not have any effect on physiological losses in weight in mangoes.

Table I. *Cumulative percentage physiological* losses in weight in Badami mangoes during storage*
(Means of six estimations)

Treatments	Mean wt. of a single fruit. (g)	Per cent loss during storag after days				
		4	8	12	16	20
Control ...	305	3.0	6.8	10.2	12.5	15.8
6 per cent wax emulsion + 1 per cent fungicide ...	323	1.9	4.1	6.0	8.1	10.
6 per cent wax emulsion + 1 per cent fungicide+250 ppm of MH	343	1.7	4.3	6.2	8.3	10.
6 per cent wax emulsion + 1 per cent fungicide + 20 ppm of 2, 4-D ...	312	1.9	4.1	6.2	8.2	10.

*Losses in wt. due to respiration and transpiration.

Tables II and III indicate gradual increas in total soluble solids (T.S.S.) and gradual decrease in acidity in treated fruits during storage However, increase in T.S.S. and decrease i acidity were comparatively faster in contro fruits. This may be due to rapid ripening i case of control fruits as against delayed ripenin in treated fruits.

TABLE II. *Changes in per cent of total soluble solids* (fresh wt. basis) in Badami mangoes during storage* (Original value, 9.0 per cent)

Treatments	Per cent, after days storage				
	4	8	12	16	20
Control ...	12.0	14.0	15.5	16.0	17.5
6 per cent wax emulsion + 1 per cent fungicide ...	11.0	13.0	14.5	15.0	16.5
6 per cent wax emulsion + 1 per cent fungicide + MH 250 ppm	11.0	12.5	14.0	15.5	16.5
6 per cent wax emulsion + 1 per cent fungicide + 2, 4-D 20 ppm ...	10.5	12.0	13.0	14.5	16.0

*Estimated by refractometer.

TABLE III. *Changes in total acidity* (as malic acid, on fresh wt. basis) in Badami mangoes during storage* (Original value 4 per cent)

Treatments	Per cent, after days storage				
	4	8	12	16	20
Control ...	2.55	1.68	0.68	0.49	0.34
6 per cent wax emulsion + 1 per cent SOPP	3.02	1.81	1.34	1.07	0.49
6 per cent wax emulsion + 1 per cent SOPP + MH 250 ppm	3.15	2.14	1.47	1.07	0.40
6 per cent wax emulsion + 1 per cent SOPP + 2, 4-D 20 ppm	3.08	2.08	1.81	1.41	0.49

*Estimated by titration of an aqueous extract with 0.1N, NaOH and calculated as malic acid.

The decrease in acidity was at a slower rate in fruits coated with aqueous fungicidal wax emulsion containing growth regulator at initial stages of storage. At the end of 20 days' storage, the acidity was higher in all the treated fruits as compared to controls. Among the treatments, fruits treated with wax emulsion containing MH showed less accumulation of organic acids than the other two treatments.

The retention of vitamin C content in fruits treated with aqueous fungicidal wax emulsion with or without growth regulator was better as compared to controls during storage period of 16 days. However, there was sharp fall at the end of 20 days among various treatments. Fruits treated with wax emulsion containing 2, 4-D showed comparatively less retention of vitamin C (Table IV).

TABLE IV. *Changes in vitamin C content* (mg/100g. on fresh wt. basis) of the edible portion of Badami mangoes during storage.* (Original value 91 mg.)

Treatments	After days storage				
	4	8	12	16	20
Control	57.2	48.4	42.0	21.6	19.4
6 per cent wax emulsion+1 per cent fungicide ...	76.0	65.9	56.2	58.0	28.1
6 per cent wax emulsion+1 per cent fungicide+ 250 ppm MH	72.0	64.0	55.1	48.6	28.1
6 per cent wax emulsion+1 per cent fungicide+ 20 ppm 2, 4-D	91.0	76.0	57.2	50.8	21.6

*Estimated by titration against a standard solution of 2 : 6-dichlorophenolindophenol.

Mangoes treated with fungicidal aqueous wax emulsion containing 2, 4-D and MH retained moisture better in the early part of the storage period than the fruits waxed without growth regulator (Table V).

TABLE V. *Percentage moisture content* in Badami mangoes during storage.* (Original value 82.0 per cent)

Treatments	Per cent, after days storage				
	4	8	12	16	20
Control	76.0	74.0	74.0	71.0	70.0
6 per cent wax emulsion + 1 per cent fungicide ...	79.0	77.8	76.0	75.0	73.8
6 per cent wax emulsion + 1 per cent fungicide+250 ppm MH	80.9	77.6	76.8	73.5	72.4
6 per cent wax emulsion + 1 per cent fungicide+20 ppm 2, 4-D	79.1	75.9	75.0	74.3	73.9

* 10 g. of edible portion dried at 75°C for 16 hours.

The ripening rate in the case of mangoes waxed with or without growth regulator was significantly slower as compared with the unwaxed fruits (Table VI). The percentage of green fruits was more in mangoes waxed with aqueous fungicidal wax emulsion containing growth regulator after 16 days of storage. However after 20 days, the difference was very little. This indicates that the treatments with growth regulator delay ripening considerably in mangoes. The unwaxed fruits turned yellow as early as five days after harvest and continued to ripen at a rapid rate.

Table VI. *Percentage of mangoes retaining the green colour during storage*
(average of two replications of 50 fruits each)

Treatments	Per cent after days storage				
	4	8	12	16	20
Control	91	33	7	1	1
6 per cent wax emulsion + 1 per cent fungicide ...	98	81	35	1	1
6 per cent wax emulsion + 1 per cent fungicide + MH 250 ppm	97	84	43	12	2
6 per cent wax emulsion + 1 per cent fungicide + 2, 4-D 20 ppm	98	91	46	11	1

The respiration rates measured at 85°F in variously treated mangoes during storage have been plotted in Fig. 1. The climacteric peak of respiration occurred on 4th day for unwaxed fruits; on the 8th day for fruits waxed with fungicidal wax emulsion containing 2, 4-D; and on the 12th day for the rest of the two treatments. The peak rates of respiration correspond with the greenish yellow stage during ripening of *Badami* mangoes. The respiration rate was comparatively low in fruits treated with wax emulsion containing 2, 4-D, showed early climacteric but post-climacteric respiration rates were the lowest. This shows the possibility of retarding the ripening process during 'senescence'. However, the high rate of respiration in fruits due to common impurity like 2, 4-Dichlorophenol present in the commercial preparation of 2, 4-D, cannot be ruled out[14, 15].

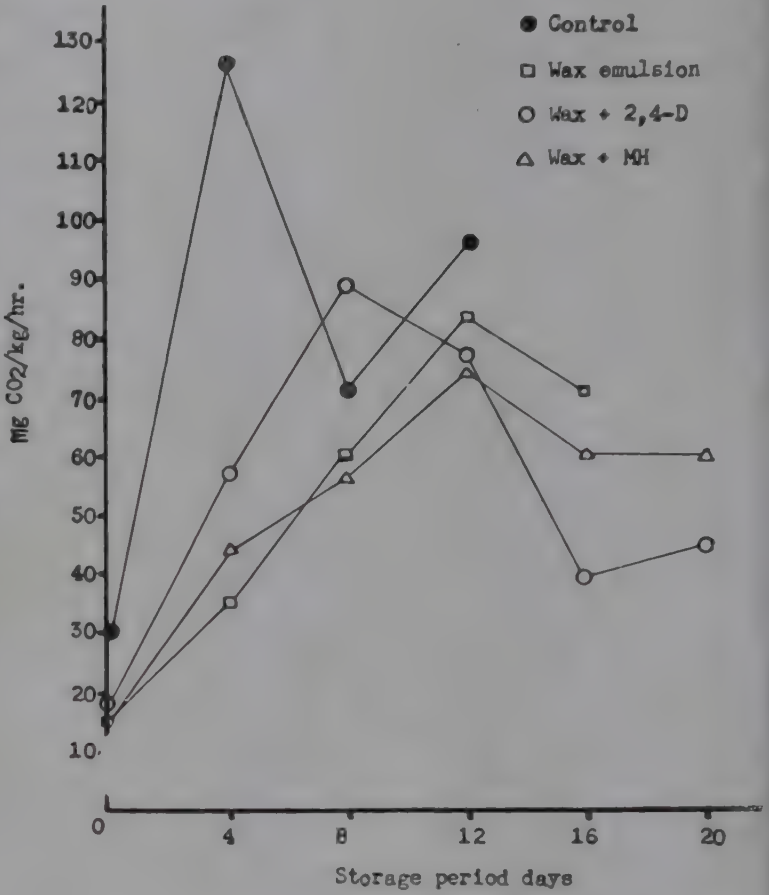

Fig. 1. Respiration rates measured at 85°F in variously treated mangoes during storage

The percentage wastage due to diseases was high in all the treated and untreated lots (Table VII). There was delaying effect on the visible symptoms of disease in fruits waxed with or without growth regulator. It is evident that the incipient infection in mangoes cannot be controlled by wax emulsion containing 1 per

Table VII. *Percentage wastage due to diseases in Badami mangoes during storage* (average of two replications of 50 fruits each)

Treatments	Per cent, after days storage				
	4	8	12	16	20
Control	2	4	10	14	19
6 per cent wax emulsion + 1 per cent fungicide ...	1	2	5	14	19
6 per cent wax emulsion + 1 per cent fungicide + MH 250 ppm	0	1	5	14	21
6 per cent wax emulsion + 1 per cent fungicide + 2, 4-D 20 ppm... ...	0	2	5	16	26

cent SOPP (sodium orthophenyl phenate) with or without growth regulator used in this investigation.

The high percentage of wastage which was encountered in fruits in this investigation was due to incipient infection caused by *Collectotrichum* sp., during growth of the fruit. This infection could be avoided by periodical application of effective fungicides on the tree.

Summary

Mangoes (*Alphonso*), were dipped in aqueous wax emulsion containing 6 per cent solids and 1 per cent sodium orthophenyl phenate, with or without growth regulator like maleic hydrazide or 2, 4-dichloro phenoxy acetic acid; and after drying in a current of hot air, fruits were stored at 78-86°F and R.H. 55-87 per cent. There was considerable delay in ripening in the treated fruits as compared to the control. The treatments containing growth regulator in the given concentration of the wax emulsion had more percentage of green fruits, between the 12th and 16th day of storage as compared to control or waxed fruits. However, there was no significant difference between the two treatments containing growth regulator. The unwaxed fruits ripened within six days as compared to the treated fruits which ripened on the 12th day. The fungicide used in the above wax emulsion delayed the development of incipient infection, but failed to control the decay in fruits during ripening.

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Authors are grateful to Dr V. Subrahmanyan, Director and Dr A. Sreenivasan, Deputy Director for their keen interest in the work.

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STUDIES ON THE EFFECT OF REPEATED WAX COATINGS ON THE STORAGE BEHAVIOUR OF COORG ORANGES (*Citrus reticulata, Blanco*)

By V. B. Dalal, H. Subramanyam and H. C. Srivastava
(*Central Food Technological Research Institute, Mysore*)

The skin coating of fresh fruits and vegetables reduces their metabolic activity by lowering their respiration and transpiration rates, thus successfully prolonging the storage life[1-4]. Recently it has been shown that skin coating of citrus fruits with 6 per cent aqueous fungicidal wax emulsion improved the storage life and marketability of fruits at room temperature[5]. It is now believed that storage life of oranges is directly related to the composition of the internal atmosphere as affected by temperature, washing and waxing[6]. Since no information seems to be available on the effect of several coatings of wax emulsion on the internal atmosphere as represented by the storage behaviour of fruits and vegetables, the present investigations were, therefore, undertaken to study the effect of repeated fungicidal wax coating on the storage behaviour of Coorg oranges at room temperature.

Experimental

The Coorg oranges for this investigation were picked from an orchard 60 miles from Mysore and were fully mature, orange in colour and free from disease. The fungicidal wax emulsion (waxol) developed at the Central Food Technological Research Institute, Mysore, which contained the ingredients: refined sugarcane wax—26 parts, carnauba wax—13 parts, oleic acid—4 parts, triethanylamine—8 parts, bleached lac—40 parts and liquour ammonia—10 parts, was used. The fruits were divided into eleven lots of one hundred fruits each with two replicates. Ten lots were treated with an aqueous fungicidal wax emulsion containing 4 per cent solids and 1 per cent sodium ortho phenyl phenate, and one lot was used as the control. The treatments were as follows: (*i*) control; (*ii*) oranges waxed by dipping once

Table I. *Cumulative percentage physiological losses* in weight in Coorg oranges during storage*

Treatment	Per cent loss on storage (after days)					
	4	8	12	16	20	24
(i) Control	4.35	8.10	12.02	16.41	20.20	23.70
(ii) Waxol—1 minute dip once	3.95	6.92	10.14	13.78	17.30	20.78
(iii) ,, 1 minute dip twice when wet	4.47	8.34	12.08	15.98	18.71	20.90
(iv) ,, 1 minute dip thrice when wet	3.90	7.54	10.90	14.40	17.28	20.80
(v) ,, 1 minute dip four times when wet	4.03	7.94	11.15	15.50	17.70	20.99
(vi) ,, 1 minute dip twice with alternate drying ...	3.80	6.90	9.53	13.35	18.42	21.34
(vii) ,, 1 minute dip thrice with alternate drying ...	3.80	7.16	10.52	14.27	18.20	21.42
(viii) ,, 1 minute dip four times with alternate drying ...	4.36	8.07	11.55	15.91	20.35	24.53
(ix) ,, 1 minute dip second time on third day ...	3.66	6.73	10.17	13.92	17.77	20.87
(x) ,, 1 minute dip third time on sixth day	4.01	6.30	10.28	14.34	18.74	21.65
(xi) ,, 1 minute dip fourth time on ninth day ...	3.93	7.20	10.65	15.20	19.64	22.81

* Losses in weight due to respiration and transpiration.

in the waxol for one minute, drained and dried; (*iii*), (*iv*) and (*v*): dipping of fruits in the waxol for one minute, twice, thrice and four times, respectively, without drying prior to subsequent dips but dried prior to storage; (*vi*), (*vii*) and (*viii*): dipping of fruits, twice, thrice and four times in the waxol for one minute, respectively, and drying after each dip; (*ix*), (*x*) and (*xi*): fruits initially waxed with the waxol followed by rewaxing after three days of all the three lots, further followed by rewaxing after six days of two lots (*x*) and (*xi*) and lastly followed by rewaxing after nine days of the lot (*xi*). Care was taken to see that all fruits were dry prior to storage at room temperature (79-86°F, relative humidity 55-87 per cent). Observations at periodical intervals of four days were made for physiological losses in weight, percentage wastage due to diseases, shrivelling, marketability as judged by retention of gloss, texture and quality, burns due to fungicide and respiration rates. Initial and final changes in vitamin C, titratable acidity, total soluble solids and juice content were recorded.

Results and Discussion

The results are given in Tables I, II and III.

It is evident from Table I that the physiological losses in weight in Coorg oranges during storage varied from treatment to treatment. The physiological losses in weight were recorded higher for fruits in treatments (*i*), (*viii*) and (*xi*). Subsequent dipping in wax emulsion while wet twice, thrice or four times (*ii-v*) prior to drying failed to show any significant difference in physiological losses in weight. Treatments (*vi*) to (*viii*) showed tendency towards more moisture loss. A second waxing after three days showed lower physiological losses in weight.

The percentage wastage due to diseases, shrivelling, marketability and burns due to fungicide are indicated in Table II. The wastage due to diseases was high in treatments (*i*), (*vii*), (*viii*) and (*xi*). The latter three treatments with high wastage may be attributed to physiological disorders which occurred due to shrivelling and burns. It is evident from this table that longer the exposure of fruits to wax emulsion containing 1 per cent fungicide, large number of fruits tend to come down with severe peel burns and in addition to this, marked shrivelling prevails[7]. This is also indicative of the fact that dipping in fungicidal wax emulsion more than two times is detrimental to the marketability of fruits. The only treatment which had 88 per cent of fruits marketable at the end of the storage period of 24 days included fruits which were waxed twice by alternate dipping and drying (*vi*). The fruits in treatment (*ii*) had only 72 per cent marketable fruits and 24 per cent were shrivelled.

TABLE II. *Cumulative percentage wastage, shrivelling, marketability and burns in Coorg oranges during storage*

Treatment		Initial	Per cent, after days					
			4	8	12	16	20	24
(i)	Decay	0	0	4	4	6	6	...
	Shrivelling ...	0	12	30	34	84	94	...
	Burns ...	0	0	0	0	0	0	...
	Marketability ...	100	88	66	62	10	0	...
(ii)	Decay ...	0	0	0	0	0	4	4
	Shrivelling ...	0	0	0	4	14	20	24
	Burns ...	0	0	0	0	0	0	0
	Marketability ...	100	100	100	96	86	76	72
(iii)	Decay ...	0	0	0	0	0	0	0
	Shrivelling ...	0	0	0	2	20	20	25
	Burns ...	0	0	0	0	0	0	0
	Marketability ...	100	100	100	98	80	80	75
(iv)	Decay ...	0	0	0	0	0	0	0
	Shrivelling ...	0	0	0	0	16	20	23
	Burns ...	0	4	6	6	6	6	6
	Marketability ...	100	96	94	94	78	74	71
(v)	Decay ...	0	0	0	0	0	0	0
	Shrivelling ...	0	0	0	0	8	32	38
	Burns ...	0	14	14	14	14	14	14
	Marketability ...	100	86	86	86	78	54	48
(vi)	Decay ...	0	0	0	0	0	0	0
	Shrivelling ...	0	0	0	4	12	12	12
	Burns ...	0	0	0	0	0	0	0
	Marketability ...	100	100	100	96	88	88	88
(vii)	Decay ...	0	0	0	0	0	0	8
	Shrivelling ...	0	0	0	8	28	40	40
	Burns ...	0	16	16	16	24	40	48
	Marketability ...	100	84	84	76	48	20	4
(viii)	Decay ...	0	0	0	0	0	0	8
	Shrivelling ...	0	0	0	8	20	40	44
	Burns ...	0	16	16	16	36	48	48
	Marketability ...	100	84	84	76	44	12	0
(ix)	Decay ...	0	0	0	0	2	4	6
	Shrivelling ...	0	0	0	0	20	40	44
	Burns ...	0	0	0	0	0	0	0
	Marketability ...	100	100	100	100	84	74	70
(x)	Decay ...	0	0	0	0	0	0	0
	Shrivelling ...	0	0	0	4	16	22	26
	Burns ...	0	0	0	0	4	4	8
	Marketability ...	100	100	100	96	80	74	66
(xi)	Decay ...	0	0	0	0	0	0	8
	Shrivelling ...	0	0	4	6	26	40	48
	Burns ...	0	0	0	0	8	16	26
	Marketability ...	100	100	96	94	66	44	18

TABLE III. *Changes in vitamin C, total acidity, total soluble solids, juice content and sugar content in variously treated oranges during storage*

Treatment	Changes in vitamin C content* (mg. per 100ml. juice)		Changes in % of total acidity†		Changes in % of total soluble solids‡		Changes in % of juice content$	
	Initial	Final	Initial	Final	Initial	Final	Initial	Final
(i)	35	28	0.518	0.441	8.5	10.5	56	46.4
(ii)	35	32	0.518	0.476	8.5	10.0	56	51.0
(iii)	35	25	0.518	0.469	8.5	10.0	56	51·0
(iv)	35	27	0.518	0.469	8.5	10.0	56	49.0
(v)	35	25	0.518	0.469	8.5	10.0	56	50.0
(vi)	35	31	0.518	0.470	8.5	10.0	56	52.0
(vii)	35	27	0.518	0.468	8.5	10.0	56	51.5
(viii)	35	25	0.518	0.476	8.5	10.0	56	51.0
(ix)	35	31	0.518	0.447	8.5	10.0	56	52.0
(x)	35	29	0.518	0.446	8.5	10.0	56	51.4
(xi)	35	27	0.518	0.446	8.5	10.0	56	50·0

* Vitamin C content estimated by titration of juice against a standard solution of 2: 6 dichlorophenol-indophenol.

† Acidity (expressed as citric acid) estimated by titration of juice with 0·1N sodium hydroxide and calculated as citric acid.

‡ Total soluble solids estimated by refractometer.

$ Juice was extracted and percentage was calculated based on the whole fruit.

From the stand point of marketability, gloss and firm texture, fruits included in treatments (*ii*), (*iii*) and (*vi*) were the best out of the whole lot at the end of the storage period. The unwaxed fruits shrivelled faster than the waxed fruits and therefore, became unmarketable at the end of storage period.

The respiration rates measured at 85°F in the variously treated Coorg oranges during storage are recorded in Figure 1. The respiration rates were low for all the waxed fruits as compared to control. However, wide fluctuations in the rate of respiration were noted in fruits with repeated wax coatings.

It is seen from Table III that percentages of total soluble solids increase and the percentages of acidity, vitamin C and juice content decrease, in Coorg oranges during storage. Vitamin C retention was better in fruits in treatments (*ii*), (*vi*) and (*ix*). Percentage acidity and juice content were high in all the treated fruits as compared to the control.

The organoleptic assessment of treated and untreated fruits at the end of storage period of 24 days revealed that Coorg oranges waxed once and twice were acceptable in flavour, taste and colour. The unwaxed fruits became flat in taste and therefore, were not acceptable.

Summary

Freshly harvested, mature, orange coloured and healthy Coorg oranges were subjected to fungicidal wax coatings by dipping them once, twice, thrice and four times, with or without alternate drying, in an aqueous wax emulsion containing 4 per cent solids and 1 per cent sodium ortho phenyl phenate. Treated and untreated fruits were stored at room temperature (79-86°F; relative humidity 55-87 per cent) for a period of twenty four days and their storage behaviour

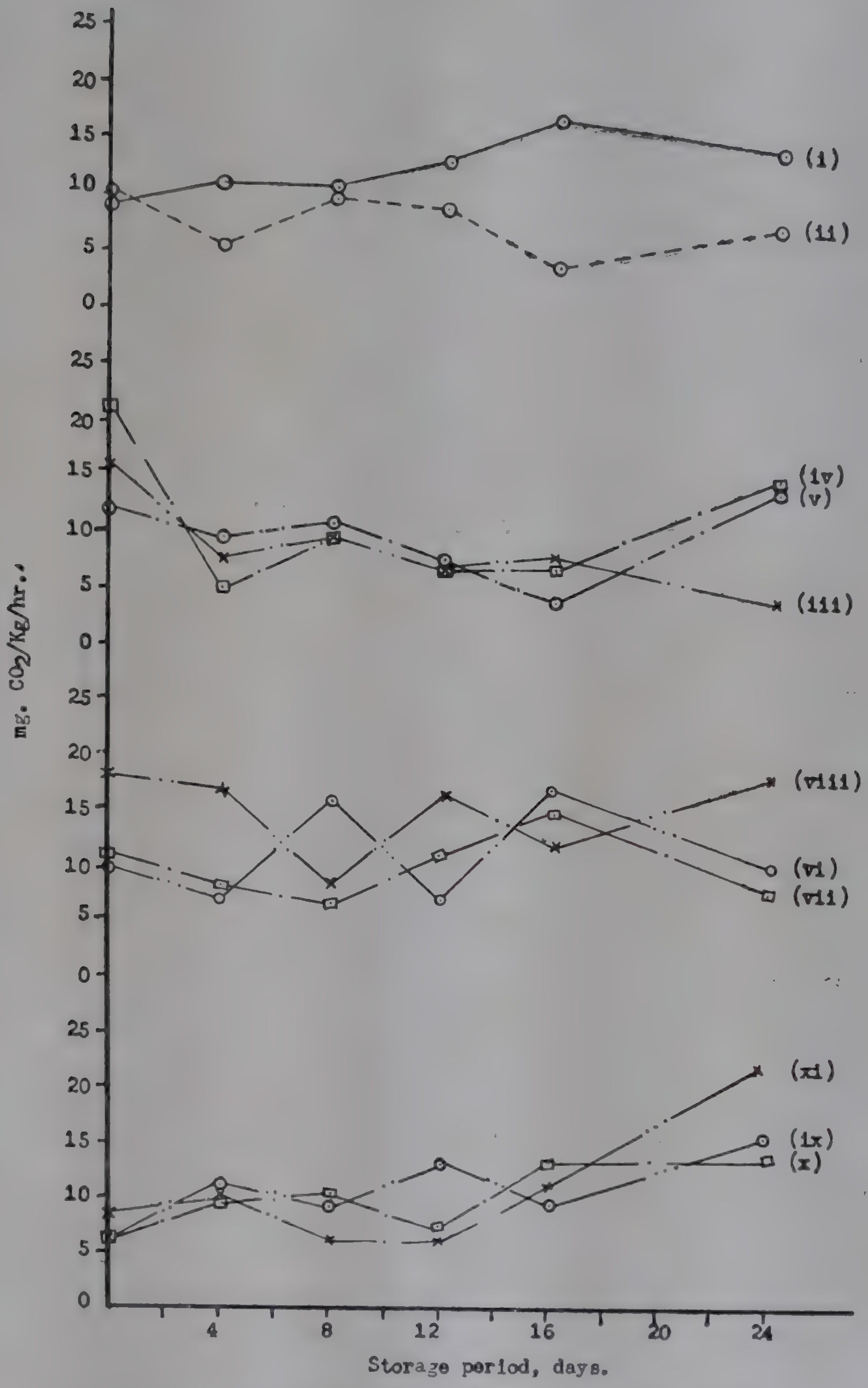

FIG. 1. Respiration rate of variously treated Coorg oranges (treatments (i)-(xi) see text)

was studied with reference to physiological losses in weight, percentage wastage due to diseases, marketability, shrivelling, burns due to fungicide, changes in vitamin C, titratable acidity, total soluble solids, juice content and respiration rate. The physiological losses in weight were high for fruits in treatments (*i*), (*viii*) and (*xi*), and lowest in (*ii*). The cumulative percentage wastage was high in treatments (*i*), (*vii*), (*viii*) and (*xi*). Shrivelling was high in unwaxed fruits and only 66 per cent of the fruits remained marketable after 8 days as against 88 per cent after 24 days in treatment (*vi*). Coorg oranges coated more than twice with aqueous fungicidal wax emulsion containing 1 per cent sodium ortho phenyl phenate resulted in damage to the peel of the fruits and poor marketability. Fruits waxed twice by alternate dipping and drying (*vi*) showed no wastage, minimum shrivelling and gave large number of marketable fruits with excellent gloss and firm texture at the end of 24 days of storage at room temperature. Vitamin C, juice content and titratable acidity decreased and total soluble solids increased gradually in waxed fruits. These studies revealed the limitations associated with repeated wax coatings on Coorg oranges.

Acknowledgment

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STORAGE BEHAVIOUR OF SKIN COATED GUAVAS (*Psidium guajava*) UNDER MODIFIED ATMOSPHERE

By H. C. Srivastava, N. S. Kapur, V. B. Dalal, H. Subramanyam, S. D'Souza and K. Sarveshwara Rao

(*Central Food Technological Research Institute, Mysore*)

In India, 1,25,327 acres of land are cultivated for guava yielding annually 27,319 tons[1]. It is a highly perishable commodity with a short season and therefore, proper storage and transportation become necessary to tide over the glut and reduce the spoilage. Mathur and Srivastava[2] have reported optimum conditions and approximate refrigerated storage life of guavas. It is now well known that skin coating[3-5] extends the storage life of fruits and vegetables both at room and at optimum low temperatures with considerable reduction in spoilage during storage and transportation.

Refrigerated gas storage of temperate fruits have been reported extensively by several workers.[6] Singh, Seshagiri and Gupta[7] have studied the response of the respiratory systems in guavas under different concentrations of oxygen and nitrogen. Ranjan and Khan[8] have studied the respiration rate of guavas in relation to its sugar content, while passing through a senescent drift. Rao[9] has studied the refrigerated gas storage of guavas.

This investigation deals with the storage behaviour of waxed and unwaxed guavas under modified atmosphere at room as well as at optimum low temperatures.

Experimental

Guavas of standard maturity were picked from the orchard of the Central Food Technological Research Institute, Mysore. On their arrival in the laboratory, the fruits were divided into 12 lots of 150 each. The following two wax compositions were tried on the fruits.

Wax I

Carnauba wax	43.50 parts
Thermoplastic resin	35.52 ,,
Oleic acid	5.00 ,,
Triethanolamine	17.98 ,,

Wax II

Carnauba wax	40 parts
Low melting paraffin wax	40 ,,
Oleic acid	12 ,,
Triethanolamine	8 ,,

In the preliminary experiments it was found that 5 per cent CO_2 had no pronounced effect

TABLE I. *Percentage wastage due to diseases in guavas during storage*
(Average of two replications of 50 fruits each)

	Treatments	Room temperature			Low temperature			
		After days			After days			
		3	6	8	7	14	21	28
1	Control	0	12.0	48.0	0	5.0	15.0	60.0
2	Wax I	0	4.0	21.0	0	0	0	50.0
3	Wax II...	0	4.0	6.0	0	0	0	40.0
4	Wax II + 7.5% CO_2 ...	0	7.0	12.4	0	0	5.8	0.0
5	7.5% CO_2	0	6.0	10.0	0	0	6.0	25.0
6	10% CO_2	0	10.0	16.0	0	0	21.0	35.0

n storage behaviour of guava. Waxed and unwaxed guavas were therefore kept under 7.5 and 10 per cent CO_2 atmosphere. The required CO_2 concentration in the container was maintained by introducing CO_2 from the cylinder by replacing the air. Fruits were dipped in the wax emulsion for one minute, drained and dried with the help of an electric fan.

The treatments were as follows and each treatment was replicated twice:

1. Control (without any treatment)
2. Dipped in wax emulsion I—3 per cent solids.
3. Dipped in wax emulsion II—3 per cent solids.
4. Dipped in wax emulsion II and stored in 7.5 per cent CO_2 atmosphere.
5. Stored in 7.5 per cent CO_2 atmosphere (without wax treatment)
6. Stored in 10 per cent CO_2 atmosphere (without wax treatment).

One set of fruits treated as above was stored at 47-50°F and R.H. 85-90 per cent and the other set at room temperature, 72-85°F and R.H. 40-60 per cent. Changes in acidity, ascorbic acid, cumulative physiological losses in weight, wastage due to diseases, respiration rate and moisture content were determined at regular intervals by the methods indicated at the bottom of each table. Respiration rates of fruits were recorded at regular intervals by continuous current method at 67-70°F for fruits stored at 47-50°F and at room temperature for fruits stored at 72-85°F.

Results and Discussion

The results obtained are recorded in Tables I-V and Figs. 1 and 2.

Wastage: In Table I the percentage wastage in guavas during storage under different conditions has been recorded. It can be seen that at room temperature there was a loss of 48 per cent in the control, after 8 days of storage as against only 6 per cent among the fruits treated with wax emulsion II. Similarly the wastage was minimum in fruits treated with wax II and stored under 7.5 per cent CO_2.

At low temperature, there was no loss due to wastage in the wax treated fruits upto a period of 21 days while the fruits in the control lot and 10 per cent CO_2 atmosphere showed losses of 15 and 21 per cent respectively. After 28 days of storage, there was a heavy loss in all the treatments, the least being 25 per cent in the case of fruits stored under 7.5 per cent CO_2 atmosphere as against 60 per cent in the control.

Thus it is seen that the waxing of guavas is more beneficial than the gas storage or combination of the gas storage and waxing from the point of view of wastage.

Cumulative percentage losses in weight: (Table II). After 8 days of storage at room temperature there were losses of 8.73 per cent and 9.88 per cent in fruits coated with wax emulsion I and II

TABLE II. *Cumulative percentage physiological* losses in weight in guavas during storage*
(Means of six estimations)

Serial No.	Treatments	Room temperature			Low temperature			
		After days			After days			
		3	6	8	7	14	21	28
1	Control	4.1	8.5	11.8	6.2	8.4	14.8	14.8
2	Wax I	3.1	6.0	8.7	3.5	6.4	11.8	11.8
3	Wax II	2.8	5.9	9.9	3.1	5.6	5.6	10.0
4	Wax II + 7.5% CO_2 ...	3.0	7.0	12.4	0.8	2.0	4.8	6.8
5	7.5% CO_2	4.0	6.0	10.0	0.5	0.5	4.0	9.5
6	10% CO_2	2.0	10.0	16.0	0	7.5	12.5	17.5

* Losses in weight due to respiration and transpiration.

TABLE III. *Changes in total acidity* (as citric acid, fresh weight basis) in guavas during storage*
(Original value 0.22%)

Serial No.	Treatments	Room temperature			Low temperature			
		After days			After days			
		3	6	8	7	14	21	28
1	Control	0.22	0.64	0.34	0.40	0.56	0.64	0.61
2	Wax I	0.22	0.50	0.22	0.46	0.64	0.49	0.60
3	Wax II	0.22	0.40	0.25	0.50	0.47	0.61	0.56
4	Wax II + 7.5% CO_2 ...	0.21	0.41	0.31	0.50	0.73	0.39	0.28
5	7.5% CO_2	0.21	0.40	0.34	0.39	0.59	0.53	0.50
6	10% CO_2	0.21	0.40	0.31	0.42	0.50	0.48	0.36

* Estimated by titration of an aqueous extract with 0.1N, NaOH and calculated as citric acid.

respectively. However, the fruits stored under modified atmosphere and in the control showed higher physiological losses in weight. At low temperature, after 28 days of storage, the cumulative percentage physiological losses in weight were the least in fruits coated with wax emulsion II and stored under 7.5 per cent CO_2 atmosphere followed by fruits stored under 7.5 per cent CO_2 alone and fruits coated with wax emulsion II. The rest of the treatments had more than 10 per cent physiological losses in weight.

Changes in acidity: (Table III). During storage the acidity in guava increased first and then decreased. However, there was steep increase in acidity on the 6th day at room temperature followed by a decrease on the 8th day of storage in all the treatments.

Similarly fruits stored at low temperature showed gradual increase in acidity in the early part of the storage period followed by decrease on the 28th day.

Changes in ascorbic acid: Table IV shows the changes in ascorbic acid content of guavas under different storage conditions. The ascorbic acid content of guavas at room temperature increased during first 6 days of storage under

TABLE IV. *Changes in vitamin 'C'* content (mg./100 g. fresh wt.) in guavas during storage*
(Original value 180 mg.)

Serial No.	Treatments	Room temperature			Low temperature			
		After days			After days			
		3	6	8	7	14	21	28
1	Control	200.0	220.0	159.0	118.0	244.0	206.0	172.0
2	Wax I	210.0	225.0	145.0	174.0	153.0	176.0	263.0
3	Wax II	230.0	200.0	143.0	172.0	146.0	185.0	254.0
4	Wax II + 7.5% CO_2 ...	190.5	249.3	168.4	269.0	267.5	263.1	259.0
5	7.5% CO_2	190.0	224.9	180.0	257.3	241.1	210.2	208.0
6	10% CO_2	192.1	220.5	170.2	264.7	257.3	238.1	235.0

* Estimated by titration against a standard solution of 2:6 dichlorophenol indophenol.

TABLE V. *Percentage moisture* content in guavas during storage.* (Original value 84.6)

Serial No.	Treatments	Room temperature			Low temperature			
		After days			After days			
		3	6	8	7	14	21	28
1	Control	83.9	82.5	79.5	82.2	79.5	77.7	75.0
2	Wax I	82.2	83.0	81.3	82.4	80.5	81.3	79.0
3	Wax II	83.4	82.8	81.9	84.2	80.3	82.0	80.0
4	Wax II + 7.5% CO_2 ...	83.9	83.0	82.5	84.4	84.0	83.0	82.0
5	7.5% CO_2	83.0	80.0	79.9	83.5	82.0	81.0	80.5
6	10% CO_2	82.0	80.0	78.8	82.6	81.0	80.0	79.5

* 10 g. of edible portion dried at 75°C for 16 hours.

all conditions and then decreased after 8 days. The value was highest after 8 days in fruits stored under 7.5 per cent CO_2.

At low temperature the ascorbic acid value rose upto a period of 14 days and then decreased. The highest value attained after 28 days of storage was in fruits treated with wax I followed by fruits coated with wax II, gas stored and control.

Moisture content: Table V records the moisture content of guavas under different storage conditions. The moisture content in guavas continuously decreased in all the cases. The least moisture loss was recorded in the fruits coated with wax II and stored in 7.5 per cent CO_2 atmosphere.

Respiration rate: The respiration rates of variously treated fruits have been plotted in Figs. 1 and 2. The minimum rate of respiration was observed in fruits treated with wax emulsion I and maximum in fruits treated with wax emulsion II and stored under 7.5 per cent CO_2 atmosphere,

Summary

Guava fruits were treated with two different compositions of wax emulsion of three per cent strength. One composition contained carnauba

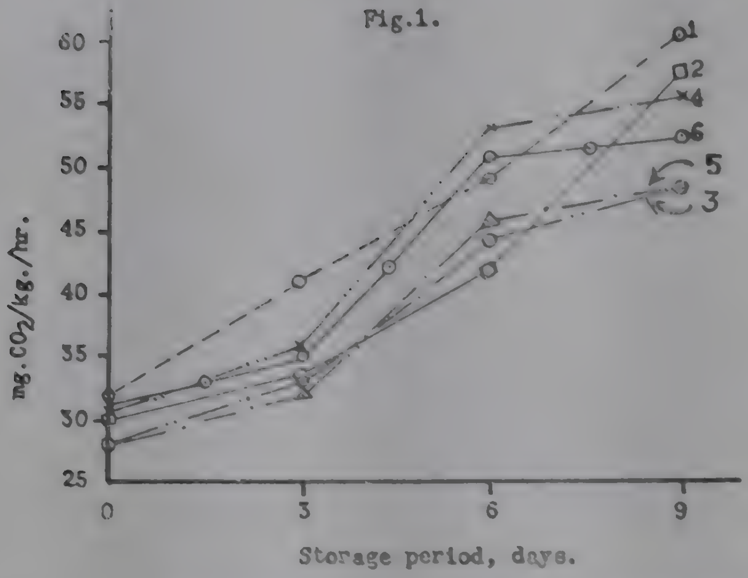

FIG. 1. Respiration rates measured at 85°F in treated guavas during storage at low temperature (1-6, refer text)

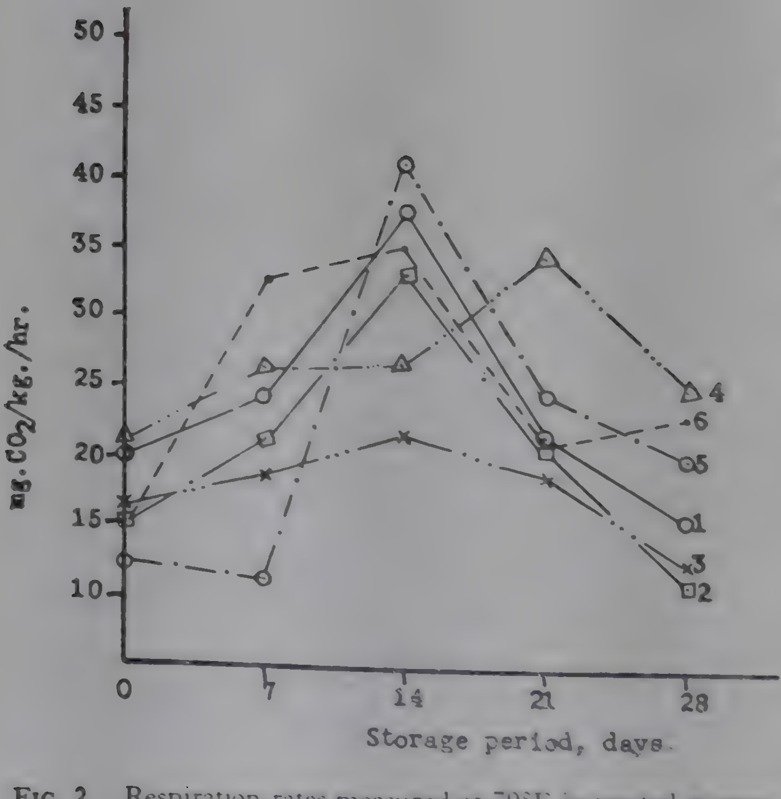

FIG. 2. Respiration rates measured at 70°F in treated guavas during storage at low temperature (1-6, refer text)

wax and a thermoplastic resin and the othe carnauba and paraffin waxes. Treated and un treated guava fruits were subjected to 7.5 and 10% CO_2 atmosphere and stored at room temp (72-85°F) and at 47-50°F. Cumulative physiological losses in weight, respiration rates, acidity ascorbic acid, moisture and wastage due to diseases were recorded at regular intervals. It wa found that storage life of waxed fruits wa extended by 80 per cent at room and 50 per cen at low temperatures, and carnauba-paraffin wa emulsion imparted a better gloss to the fruit than carnauba-resin wax emulsion. Unwaxe fruits under gas-storage conditions registere an increase of storage life both at room and lo temperature storage as compared to contro Combination of gas storage and skin coating guavas did not increase the storage life as compared to skin coating or gas storage alone.

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ROLE OF PRE-COOLING ON THE STORAGE BEHAVIOUR OF SWEET ORANGES

(*Citrus sinensis* (**Linn.**) *Osbeck*)

By N. V. N. Moorthy, N. S. Kapur and H. C. Srivastava

(*Central Food Technological Research Institute, Mysore*)

Pre-cooling of fruits and vegetables has en in practice since 1904, but it has been ccessfully exploited only recently and the pplication of pre-cooling prior to transportation, s been indicated[1-2]. The wholesale traders consuming centres have now recognized the trinsic value of pre-cooling which facilitates he marketing of different kinds of perishables n arrival at destination. The effect of pre-oling on the storage behaviour of fruits and egetables, has been investigated[3-7].

This paper deals with the effect of pre-cooling n the storage behaviour of sweet oranges.

Materials and Methods

Freshly harvested sweet oranges were obtained rom the Mysore market, and were washed in .2 per cent SOPP solution and dried in a current f cold air. The fruits were divided into two lots mmediately on their arrival in the laboratory. One lot served as control, and the other was ept at 32-35°F for about 16 hours. Periodially, the internal temperatures of the fruits were hecked by means of a thermocouple and the ruits were removed from the cold chamber as oon as the temperature at the centre of the fruit eached that of the surroundings. Then, the ruits were removed from the cold room, divided nto two lots, and stored at room temperature (75-92°F) and at 68-70°F. Controls were stored ikewise at the above two temperatures. At egular intervals of 3 days, the fruits (from the analytical lot) were analysed for cumulative physiological losses in weight (average of 5 fruits), moisture, acidity, ascorbic acid, juice percentage, peel percentage, according to the standard A.O.A.C.[8] procedures. Separate lots were kept for wastage and the optimum storage life was determined at the 10 per cent wastage level.

Results and Discussion

(*i*) *Physiological losses in weight:* The results are presented in Table I. The physiological loss in weight (PLW) is much less in the pre-cooled fruits as compared to the controls at both the storage temperatures. However, the loss is the least in the pre-cooled fruits stored at 68-70°F.

(*ii*) *Physical and chemical changes:* Changes in moisture content, acidity, ascorbic acid, juice percentage and peel percentage, are recorded in Tables II-IV respectively. There is a progressive decrease in the moisture content of the fruits in all the lots stored. The moisture retention in the pre-cooled fruits is better than the controls at both the temperatures. Similarly, the fall in acidity, no doubt is continuous in all cases, but is slower in the pre-cooled fruits at both the storage temperatures. The decrease in acidity is less at 68-70°F than that at room temperature. Table IV shows that the ascorbic acid content in the pre-cooled fruits is higher than that in the controls at both the temperatures during the entire storage period of 19 days. The juice recovery from the pre-cooled fruits was more than in the case of control stored at 68-70°F. However, there was only slight increase in the fruits stored at room temperature. Comparable results were obtained with regard to peel percentage.

(*iii*) *Wastage:* It can be seen from Table VII, that 12 and 14 per cent wastage in controls stored at 68-70°F and room temperature respectively, were reached after 19 days of storage while there was only 8 per cent wastage in the pre-cooled fruits stored at 68-70°F and 10 per cent in those stored at room temperature. This indicates the economics of pre-cooling.

It is believed that pre-cooling may be helping the fruit in developing resistance to microbial infection on account of sudden lowering of temperature.

Summary

The above investigation indicates that pre-cooling of sweet oranges helps in prolonging

TABLE I. *Physiological losses in weight (average of 5 fruits) (cumulative percentage)*

Storage temp.	Treatment	Days after treatment						
		1	4	7	10	13	16	19
68–70°F	Control	1.2	6.0	9.0	12.2	13.0	15.2	18.0
68–70°F	Pre-cooled	1.1	4.6	7.1	9.4	11.6	12.6	14.2
75–92°F	Control	4.8	8.5	10.9	13.5	17.1	18.8	21.8
75–92°F	Pre-cooled	2.0	5.2	7.7	10.1	12.8	14.5	17.2

TABLE II. *Moisture percentage*

Storage temp.	Treatment	Initial	Days after treatment						
			1	4	7	10	13	16	19
68–70°F	Control	77.1	76.3	75.4	74.2	73.6	72.8	72.2	71.
68–70°F	Pre-cooled	77.1	76.7	75.6	75.0	74.4	74.0	73.8	73.
75–92°F	Control	77.1	76.0	74.8	73.0	71.3	70.6	69.0	68.
75–92°F	Pre-cooled	77.1	76.3	75.0	74.2	72.5	73.2	72.5	71.

TABLE III. *Acidity (expressed as percentage of citric acid in the juice)*

Storage temp.	Treatment	Initial	Days after treatment						
			1	4	7	10	13	16	19
68–70°F	Control	0.54	0.53	0.52	0.52	0.50	0.50	0.49	0.4
68–70°F	Pre-cooled	0.54	0.54	0.53	0.53	0.52	0.52	0.51	0.5
75–92°F	Control	0.54	0.52	0.50	0.48	0.46	0.43	0.41	0.3
75–92°F	Pre-cooled	0.54	0.53	0.50	0.48	0.47	0.45	0.44	0.4

TABLE IV. *Ascorbic acid (expressed as mg/100 ml of juice)*

Storage temp.	Treatment	Initial	Days after treatment						
			1	4	7	10	13	16	19
68–70°F	Control	47.5	47.0	46.4	46.0	45.5	44.3	42.9	41.
68–70°F	Pre-cooled	47.5	47.2	47.0	46.6	46.1	44.8	43.6	43.
75–92°F	Control	47.5	46.2	45.0	43.2	41.8	40.0	39.0	37.
75–92°F	Pre-cooled	47.5	46.8	45.4	43.9	43.0	42.1	40.7	39.

TABLE V. *Juice percentage*

torage temp.	Treatment	Initial	Days after treatment						
			1	4	7	10	13	16	19
70°F ...	Control	48.9	48.2	47.0	46.3	44.9	43.4	42.5	41.8
70°F ...	Pre-cooled	48.9	48.5	48.1	47.5	46.6	45.9	45.1	44.6
2°F ...	Control	48.9	47.9	46.3	45.5	44.0	42.9	41.6	39.8
2°F ...	Pre-cooled	48.9	48.4	49.0	46.1	45.2	44.0	42.8	40.1

TABLE VI. *Peel percentage*

Storage temp.	Treatment	Initial	Days after treatment						
			1	4	7	10	13	16	19
70°F ...	Control	22.8	22.4	22.2	21.9	21.4	21.0	20.8	19.6
70°F ...	Pre-cooled	22.8	22.7	22.6	22.5	21.9	21.8	21.6	21.2
92°F ...	Control	22.8	22.3	22.0	21.5	20.8	20.2	19.5	18.9
92°F ...	Pre-cooled	22.8	22.5	22.2	21.7	21.2	20.6	20.2	19.4

TABLE VII. *Wastage (cumulative percentage)*

Storage temp.	Treatment	Days after treatment						
		1	4	7	10	13	16	19
68–70°F ...	Control	0	4	6	8	8	10	12
68–70°F ...	Pre-cooled	0	2	2	4	4	6	8
75–92°F ...	Control	0	8	8	10	12	12	14
75–92°F ...	Pre-cooled	0	2	4	6	6	8	10

ie storage life, better recovery of juice and eater retention of acidity and ascorbic acid.

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REFRIGERATED STORAGE BEHAVIOUR OF PRE-COOLED TOMATOES

(*Lycopersicon esculentum* (**Mill**) **Var.** *Marglobe*)

By H. C. Srivastava, N. V. N. Moorthy and N. S. Kapur

(Central Food Technological Research Institute, Mysore)

Application of pre-cooling to various fruits and vegetables as a means of extending their storage life has been tried recently[1-5]. Ildis and D'Ersu[6] have studied the effect of cold on the *smooth autumn* tomatoes and found that they failed to ripen if stored below 42°F. Similar results were obtained by Craft and Heinze[7]. This investigation deals with the refrigerated storage of pre-cooled tomatoes at different temperatures and its effect on uniform ripening and colour development.

Materials and Methods

Freshly harvested, fully grown, firm green tomatoes (var. *Marglobe*) were obtained from a nearby orchard. They were divided into two lots. One lot was kept as control and the other lot was pre-cooled at 32-35°F till the internal temperature of the fruits reached that of the surroundings. Each lot was further subdivided into 3 units and stored at 32-45°F, 47-50°F and 52-55°F respectively. At regular intervals of 4 days, samples were withdrawn from each lot and analysed for moisture content, acidity, ascorbic acid, cumulative physiological losses in weight according to the standard A.O.A.C.[8] methods. A separate lot under each treatment was kept for record of wastage.

Results and Discussions

Physiological losses in weight: Table I shows the cumulative percentage physiological losses in weight (PLW) in tomatoes stored at different temperatures (pre-cooled and controls). It can be seen that the physiological loss in weight was less in pre-cooled tomatoes stored at various temperatures as compared to control and least among pre-cooled tomatoes at 52-55°F.

Physical and chemical changes: Moisture content, acidity (expressed as citric acid) and ascorbic acid are recorded in Tables II-IV. Moisture content gradually decreases under all storage conditions, the loss being the least at 52-55°F and maximum at 42-45°F. Pre-cooling helps in the preservation of moisture content during storage. Acidity first increases upto a period of 16-20 days and then decreases slowly. Pre-cooling delays peak of acidity and helps in the retention thereafter. Ascorbic acid continuously decreases during storage. The retention of ascorbic acid is maximum in the pre-cooled tomatoes stored at 52-55°F. Pre-cooling reduces ascorbic acid losses. Ripening and colour development was uniform in tomatoes (pre-cooled and control) stored at 52-55°F. The red colour did not develop properly in tomatoes stored at 42-45°F and 47-50°F. However, there was a better colour at 47-50°F as compared to that at 42-45°F. Pre-cooling does not interfere with the normal development of the colour during ripening.

Wastage: The cumulative wastage after 28 days of storage at 42-45°F (Table V) was 12 per cent in control and 10 per cent in the pre-cooled fruits, while the wastage at 47-50°F was 8 and 10 per cent respectively in the pre-cooled and control. The wastage was the least (8 per cent in control and 6 per cent in pre-cooled) in the fruits stored at 52-55°F.

Summary

The above observations indicate that the optimum storage temperature for tomatoes (pre-cooled and control) is 52-55°F. Pre-cooling helps in the better retention of moisture and ascorbic acid, less wastage, more uniform development of colour and slowed lowering in acidity.

Acknowledgment

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TABLE I. *Physiological losses in weight (cumulative percentage)*

Storage temperature (R.H. 85–90%)	Treatment	Days after treatment							
		1	4	8	12	16	20	24	28
42–45°F	Control	0.6	0.9	1.5	1.9	2.6	3.2	3.8	3.1
	Pre-cooled	0.5	0.8	1.4	1.9	2.6	3.1	3.7	4.9
47–50°F	Control	0.7	1.2	1.7	2.4	3.0	3.4	3.8	4.9
	Pre-cooled	0.6	1.1	1.5	2.1	2.8	3.2	3.8	4.3
52–55°F	Control	0.6	0.8	1.0	1.7	2.1	2.5	3.3	3.6
	Pre-cooled	0.5	0.7	0.9	1.5	1.9	2.3	2.8	2.9

TABLE II. *Moisture percentage*

Storage temperature (R.H. 85-90%)	Treatment	Days after treatment								
		Initial	1	4	8	12	16	20	24	28
42–45°F	Control	93.1	92.4	91.8	91.1	90.6	90.2	90.0	89.9	81.7
	Pre-cooled	93.1	92.6	92.1	91.5	91.3	91.0	90.8	90.5	90.2
47–50°F	Control	93.1	92.7	92.3	91.6	91.5	91.2	91.0	90.8	90.5
	Pre-cooled	93.1	92.8	92.5	92.1	91.9	91.6	91.4	91.0	90.9
52–55°F	Control	93.1	92.9	92.7	92.5	92.3	92.0	91.7	91.4	91.1
	Pre-cooled	93.1	93.0	92.8	92.7	92.5	92.2	91.9	91.6	91.3

TABLE III. *Variation in acidity* during storage*

Storage temperature (R.H. 85–90%)	Treatment	Days after treatment								
		Initial	1	4	8	12	16	20	24	28
42–45°F	Control	0.45	0.48	0.49	0.51	0.52	0.53	0.52	0.50	0.48
	Pre-cooled	0.45	0.47	0.48	0.49	0.51	0.52	0.55	0.53	0.51
47–50°F	Control	0.45	0.48	0.50	0.52	0.54	0.55	0.53	0.51	0.49
	Pre-cooled	0.45	0.47	0.49	0.50	0.52	0.53	0.55	0.57	0.53
52–55°F	Control	0.45	0.49	0.50	0.53	0.54	0.56	0.54	0.52	0.50
	Pre-cooled	0.45	0.48	0.50	0.50	0.52	0.54	0.56	0.55	0.54

* Acidity was determined by direct titration against a standard alkali and was expressed as percentage of citric acid.

TABLE IV. *Variation in ascorbic acid* during storage*

Storage temperature (R.H. 85–90%)	Treatment	Days after treatment								
		Initial	1	4	8	12	16	20	24	28
42–45°F	Control	19.0	18.7	18.2	17.8	17.3	16.8	16.0	15.7	15.2
	Pre-cooled	19.0	18.8	18.5	18.0	17.6	17.2	16.7	16.3	16.0
47–50°F	Control	19.0	18.8	18.6	18.2	18.0	17.6	17.3	17.0	16.8
	Pre-cooled	19.0	18.9	18.7	18.4	18.1	17.9	17.7	17.5	17.3
52–55°F	Control	19.0	19.0	18.9	18.7	18.7	18.6	18.5	18.4	18.3
	Pre-cooled	19.0	19.0	19.0	18.9	18.8	18.7	18.6	18.6	18.5

* Ascorbic acid was determined by visual dye titration method and expressed as mg. per 100 g. of the fruit.

TABLE V. *Cumulative wastage percentage*

Storage temperature (R.H. 85–90%)	Treatment	Days after treatment							
		1	4	8	12	16	20	24	28
42–45°F	Control	0	0	0	6	8	10	10	12
	Pre-cooled	0	0	0	2	4	6	8	10
47–50°F	Control	0	0	0	4	6	6	8	10
	Pre-cooled	0	0	0	2	4	6	6	8
52–55°F	Control	0	0	0	2	4	4	6	8
	Pre-cooled	0	0	0	0	2	4	4	6

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AN INVESTIGATION INTO PRODUCTIVITY MEASUREMENT IN PINEAPPLE PROCESSING

By A. V. Venkatesam and A. Rahman
(*Central Food Technological Research Institute, Mysore*)

1. Introduction

1.1 The objective of the present *operational* *esearch* studies is to help the industry at its echnical level, by examining the practices n vogue and suggesting ways and means of mproving efficiency of production, and thus decreasing the cost of production.

1.2 Any such study involves the examining of the entire operation, from the receipt of raw material to the sale of product. The receipt of raw material involves regular quantum of supply, the size and the degree of maturity of fruit, which in turn not only involves the horticultural but also the market practices. Once the fruit has been received, the processing through a unit operation comprises sub-units and the efficiency of each of the sub-units and their co-ordination determines the overall efficiency and the cost of production. Finally, the business practices of the factory, the law of market supply and demand, and the organisation to meet these ends have their effect on the efficiency and the cost of production.

1.3 It would have been, though, desirable to study all the economic and technical aspects of the industry to work out its efficiency, for practical reasons it was decided to concentrate on the actual production practices. Further, recommendations based on such a study would not require much investment and radical changes and would create confidence in the factories for the necessity of such studies and the changes in the level of the industry.

1.3. 1 Consequently, the scope of the present study was limited to:

Examine the existing practices and work out their efficiency by:

(*a*) proper allocation of work, *with a unit operation* and co-ordination with the other,

(*b*) man—machine relationship,

(*c*) examining *line of production* and working out proper work-loads for each operation.

1.3. 2 Find out the major bottlenecks and obstructions in production.

1.3. 3 Reduce the wastage of material, time and labour.

1.3. 4 Suggest alternate *practical* methods to improve the efficiency.

1.4 To achieve this objective, extensive snap measurements were collected on *unit operations* in the production line with *respect to major operations*. In order to maximise the *efficiency* of the estimates, the snap measurements were spread over different workers over a duration. The statistical techniques employed were the same as described by Venkatesam *et al.*

2. Estimation and allocation of work-loads at unit operation

2.1 The method of estimation of the work-loads is the same as used by Venkatesam *et al.* 'The worker is said to achieve 100 per cent efficiency if he produces the standard or specified work-load during the hours of the factory.'

In assigning work-load and working out the efficiency, various factors of fatigue and operational delays have to be taken into consideration each of which in turn depends upon a number of other factors. Detailed studies in other countries have been carried out on each of the factors. In view of the fact that such a study would involve a separate study by itself, the following procedure was adopted in assigning work-loads:

Usually in time study measurements while calculating the norm for the work-load of a worker, allowances for retarding factors (*viz.*, fatigue and personal and unavoidable delay) are made to enable the operator who works at the average performance level to meet the time allowed for doing the work throughout the full day, by increasing the time for the unit operation by 15 per cent of the estimated time. Suppose the estimated time for the element (or the unit operation) is x hours and the total hours of the factory are y hours: the number of cycles of the element during a factory day expected to be performed by a worker is $\frac{Y}{1.15X} = 0.869$ y/x which should be the norm for the worker.

Instead, we have calculated the standard work-load at 100 per cent efficiency and allowed the *norm at 80 per cent of the standard* which using the same variables for the factory hours and element time as above reduces to (y/x) (80/100) 0.80 y/x, thus the norm allocated by our study is less stringent from the workers' standpoint of view than expected by the classical method[2]. Thus, as per our allotment, the norm for the work-load of a worker is the quantity of output he could turn over working 6 hours 24 minutes out of factory day of 8 hours which provides for fatigue and other factors to the extent of 24 minutes in each of the 4 shifts of two hours.

2.2 *Decrowning:* The average time required for removing the crowns and ends of a single fruit is 4.78 seconds and the work-load standard is 6024 fruits per day of 8 hours (Table III).

2.3 *Feeding the washing tank:* The average time for transport of fruits to washing tank works out to 5 *seconds per fruit per two workers*. The standard works out to 5760 *fruits* per day (Table III).

2.4 *Slicing machine:* The work-load standards at the slicing machines are the same as the operative standards of the machines. The slicer, designed at the factory, can slice more of small size fruits than the patented ones. It can slice 4,000 *small* fruits and about 3,000 *medium* sized fruits in a working day. It is not suited for big fruits and it has to be suitably altered. The patented machines can slice 3,650 *small* fruits or 2,700 *medium and big fruits*. Work-load allocation for the machine of their design and the patented ones are available in Table III, while Table I gives the detailed breakdown of time for eac element* of the unit operation—*slicing*.

Table III also provides the expected numbe of fruits which could be sliced by differer combinations of machines in a day at 80 per cer efficiency—the norm for the worker.

2.5 *Peeling:* Table II provides details the distribution of time in seconds for peelin (of slices taking 3 or 4 at a time, the average tim for peeling) a set of 3 or 4 slices is 18.85 second with 95 per cent confidence interval for produc tivity in a factory day (1519; 1537) with an expecte number of 6112 slices taking 4 silces at a tim and 4,584 slices taking 3 at a time. It seem advisable to enforce taking 4 slices at a time whic means a standard of 6,000 *slices* per worker pe working day of 8 hours.

Allocation of work-loads at 80 per cent efficienc is given in Table IV and the method of workin out the allocation figures is given in the footnote The distribution of time for peeling 3 or 4 slic is graphically represented in Figure 1.

2.6 *Punching:* It takes on the average 6.0 seconds for punching one slice and in a factor day a worker can easily punch 4745 *slices* on th average and the 95 per cent confidence interv is (4493; 5026).

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* The elements for each machine are as follows:

Elements	Slicer (Their design)	Slicer (Patented or
1	Pulling the piston out (till it reaches the maximum pull)	Removing the clamp and raising to ma mum position
2	Placing the pineapple	Placing pineapple
3	Slicing of fruit	Slicing of fruit

* For purposes of working out work-loads at peelin punching, trimming, coring and washing, etc., the fruit categorised into the following classes:

Class/Type	Length of the fruit (in inches)	Average numbe of slices
Small	4-5	6
Medium	5-6	8
Big	6-7	10
Giant	7-8	12
Colossal	8-9	14

This is on the assumption that the thickness of a sl is $\frac{1}{8}''$ and the length of the fruit is taken after crowns a ends are removed.

TABLE I. *Estimates of the parameters of the variable—"time in seconds for slicing of a fruit" and expected outcome during factory hours of a wage-day*

		Type of fruit	Sample size	Population mean	95% confidence interval	Standard (Number of expected repetitions of the operation during the factory day of 8 hrs.)		
						Lower limit	Upper limit	Average
. Slicing machine (Their design)	Element No. 1		22	0.91	0.91 ± 0.147	...	...	...
Slicing of fruits (in seconds)	Element No. 2		21	0.81	0.81 ± 0.115	...	...	...
	Element No. 3	S	57	5.47	5.47 ± 0.247	...	...	...
		M	22	7.99	7.99 ± 0.836	...	...	...
		Overall	79	6.17	6.17 ± 0.381	...	...	...
	Entire operation	S	...	7.19	7.19 ± 2.61*	2,939	6,288	4,006
		M	...	9.71	9.71 ± 4.31*	2,054	5,333	2,966
		Overall	...	7.89	7.89 ± 3.84*	2,455	7,111	3,650
2. Slicing machine	Element No. 1		12	0.57	0.57 ± 0.153	...	...	...
Patented ones	Element No. 2		12	0.70	0.70 ± 0.147	...	...	...
Slicing of a fruit	Element No. 3	S	18	6.62	6.62 ± 0.957	...	...	...
		M & B	35	9.41	9.41 ± 0.722	...	...	...
		Overall	53	8.46	8.46 ± 0.673	...	...	...
	Entire operation	S	...	7.89	7.89 ± 4.66*	2,295	7,084	3,650
		M & B	...	10.68	10.68 ± 4.86*	1,853	4,948	2,697
		Overall	...	9.73	9.73 ± 5.43*	1,900	6,697	2,960

Note: The numbers given in the last column "Standard" refer to the fruits of different types which can be sliced by the machine in question. S = small fruit of average weight 3-4½ lbs., M = 4½-6 lbs. B = 6 lbs. and more.
* This refers to 3σ limits for variable time of concerned operation.

Allocation of work-loads at 80 per cent efficiency is given in Table IV and the distribution of time for punching a slice is represented in Figure 1.

2.7 *Coring:* It takes on the average 2.82 seconds for coring a slice and the confidence interval for productivity in a day is (9351; 11,250) with expected number at 10,212 *slices.*

Allocation of work-loads at 80 per cent efficiency is given in Table IV, and the distribution of time for coring a slice is represented in Figure 1.

2.8 *Trimming:* It takes on the average 15.36 seconds for trimming a slice and the 95 per cent confidence interval is (1699; 2092) with an expected number as 1875 slices.

The allocation of work-load at 80 per cent efficiency is given in Table IV and the graphic representation of the distribution of the time for trimming a slice is represented in Figure 1.

2.9 *Washing and filling:* It takes on the average 39.45 seconds for filling a A 2½ big slices can (8 Nos.) with 95 per cent confidence interval given by (443; 2076) and expected number for a factory day, 730 cans while on the average it takes 56.39 seconds for A2½ small slices can

TABLE II. *Showing the parameters of the distribution of the time in seconds taken for each operation by a worker and the estimated number of repetitions of the operation during factory day of 8 hours with productivity in a day per worker expressed as number of slices.*

		Sample size	Population mean	95 per cent confidence interval	Standard
					Average productivity (Expressed as number of slices
Peeling		126	18.85	18.85 ± 1.07	4584* 6112**
Punching	one slice	119	6.07	6.07 ± 0.34	4745
	20 slices	60	145.60	145.60 ± 12.45	
Coring	one slice	100	2.82	2.82 ± 0.26	10,212
	20 slices	52	67.13	67.13 ± 5.36	
Trimming	one slice	159	15.36	15.36 ± 1.59	1875
	20 slices	50	267.86	267.86 ± 20.63	
Picking and counting slice from the washing tank	8 Nos.	73	25.02	25.02 ± 2.61	
	12 Nos.	50	41.96	41.96 ± 9.18	
	Trimming final touches	52	6.78	6.78 ± 1.37	
	Turning and placing in the can	52	7.65	7.65 ± 1.10	
	Entire operation 8 Nos.		39.45	39.45 ± 25.58†	5840
	Entire operation 12 Nos.		56.39	56.39 ± 66.15†	6132

NOTE: * and ** in the last column and first row refer respectively to the output taking 3 and 4 slices at a time fo peeling. † These refer to 3σ limits for the variable time of the particular operation.

TABLE III. *Allocation of work-loads at 80 per cent efficiency*

	Minimum no. of workers required for operation	Average time required in seconds per fruit		Standard or expected no. of fruits (for 8 hrs.)	Norm (Assignabl work-load) 80 per cent
1. Decrowning	One		4.78	6024	4819
2. Feeding the washing tank	Two (one minute per basket of 12 fruits)		5.0	5760	4608
3. Slicing machines (their design)	Two	Small fruit	7.19	4006	3205
		Medium fruit	9.71	2966	2373
		Overall	7.89	3650	2920
Patented	Two	Small fruit	7.89	3650	2920
		Medium and Big	10.68	2697	2158
		Overall	9.73	2960	2368
Simultaneously working their machine and one patented machine	Four	Small fruit	3.770	7639	6111
		Medium and Big	5.098	5649	4519
		Overall	4.405	6538	5230
Simultaneously working their designed machine and the two patented machines	Six	Small fruit	2.552	11285	9028
		Medium and Big	3.453	8341	6673
		Overall	3.040	9474	7579

NOTE: The figures for expected number of fruits for different combinations of machines having been computed from expected average time per fruit by the said combinations, a slight discrepancy from the totals obtained by summing the expected numbers of fruits for each of the machines will be noted.

TABLE IV. *Norm (or work-load assignments) as number of fruits per worker for different categories of fruits at 80% efficiency*

Type of fruit	Peeling[1]	Punching	Coring	Trimming	Washing and filling[2]
1. Small (Length 4 to 5 inches). Average no. of slices per fruit 6 ...	815 (611)	633	1,362	250	800
2. Medium (Length 5 to 6 inches). Average no. of slices per fruit 8	611 (458)	475	1,021	188	600
3. Big (Length 6 to 7 inches). Average no. of slices per fruit 10 ...	489 (367)	380	817	150	480
4. Giant size (Length 7 to 8 inches). Average no. of slices per fruit 12	407 (306)	316	681	125	400
5. Colossal (Length 8 to 9 inches and over). Average no. of slices per fruit 14 ...	349 (262)	271	584	107	343

NOTE: [1] The figures in brackets refer to work-load assignment taking 3 slices at a time while those without brackets refer to work-load assignments taking 4 slices at a time.

[2] The expected turnover for a factory day at washing and filling operation for small slices is 5840 slices and for big slices 6132 slices. In working work-load assignment the figures for both small and big slices is taken as 6,000 effective slices for a factory day.

(12 to 14 Nos.) with 95 per cent confidence interval given by (235, α)* and expected number in a factory day, 511 cans.

The allocation of work-load at 80 per cent efficiency is given in Table IV and graphic representation of the rate of filling of cans is shown in Figure 2.

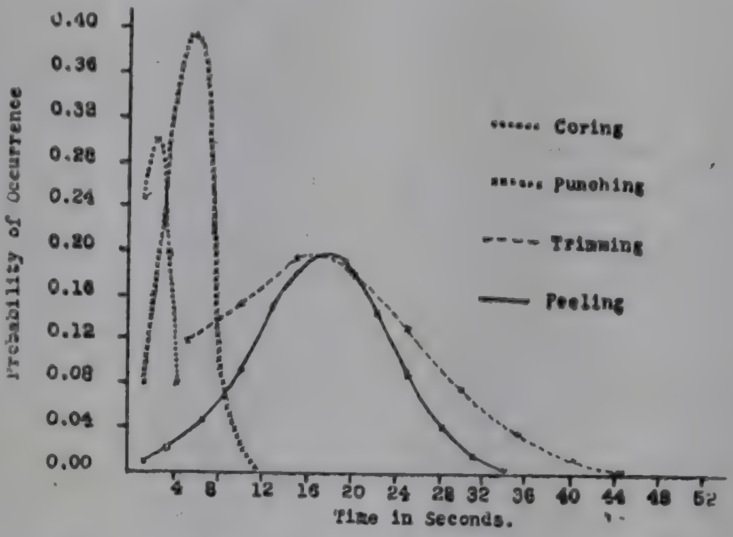
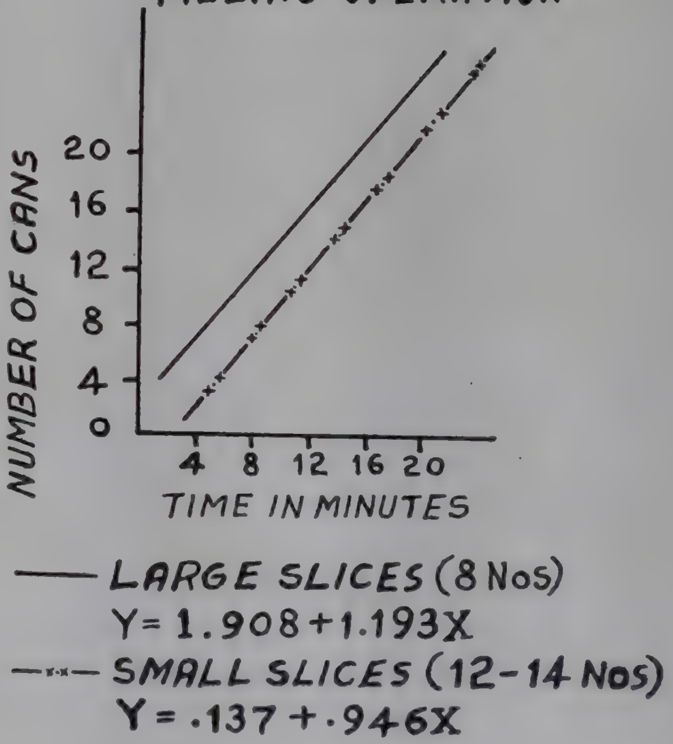


FIG. 1. Distribution curves for peeling, punching, coring and trimming operations

FIG 2. RATE OF FILLING OF CANS AT WASHING AND FILLING OPERATION



2.10 *Weighing:* The weighing of a can takes 2 to 3 seconds and a worker's standard work-load for a day of 8 hours is about 11,520 cans with proper movement of filled cans to weighing machine. The worker could, therefore, be able to cope with double the present production.

2.11. 1 *Syruping and exhaust chamber-feeding:* The prescribed output for exhaust chamber is 540 butter cans per hour and 360 A2½ cans per hour. The work-load standard for the exhaust box is 4320 butter cans or 2880 A2½ cans which is equivalent to 120 cases per factory day of 8 hours. Table V (Fig. 6) gives the production

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* Where α includes a large figure—but not determinable from the parameters of the distribution for the variable time for the unit of operation.

TABLE V. *Expected turn over of slices A2½ and Butter can for some specified inputs ranging from 10,000 lbs. to 34,000 lbs. with 95% confidence limits—at steps of 400 lbs.*

Thousand pounds	Hundred pounds					
	4			8		
	Upper limit	Average	Lower limit	Upper limit	Average	Lower limit
10	115.8	77.3	38.7	117.5	79.0	40.4
15	137.4	98.8	60.3	139.1	100.6	62.0
20	159.0	120.4	81.8	160.7	122.1	83.6
25	180.5	142.0	103.4	182.3	143.7	105.1
30	202.1	163.5	125.0	203.8	165.3	126.7
34	219.4	180.8	142.2	221.1	182.5	144.0

NOTE: The three figures for each input denote the range in the slice, yield according as variations in the ripeness of the fruit as well as the average at the given input in the long run.

of slices as per given input for variations in maturity of fruit. It is easily seen from the table that the present capacity of the exhaust chamber (120 cases) will on the average cope with productions up to 20,000 lb. during a factory day without overtime work.

The data reveals that the removal of cans from the exhaust box and seaming, very well synchronises with the feeding of exhaust box but on average per full standard crate nearly two minutes for A2½ size cans and 3 minutes for butter cans, are required more because of gap in feeding the exhaust box continuously, the movement of the worker seaming the cans, or stoppage of the exhaust box, etc. This causes very slight discontinuity in operation which is normal.

The rate of feeding the exhaust is represented in Figure 3.

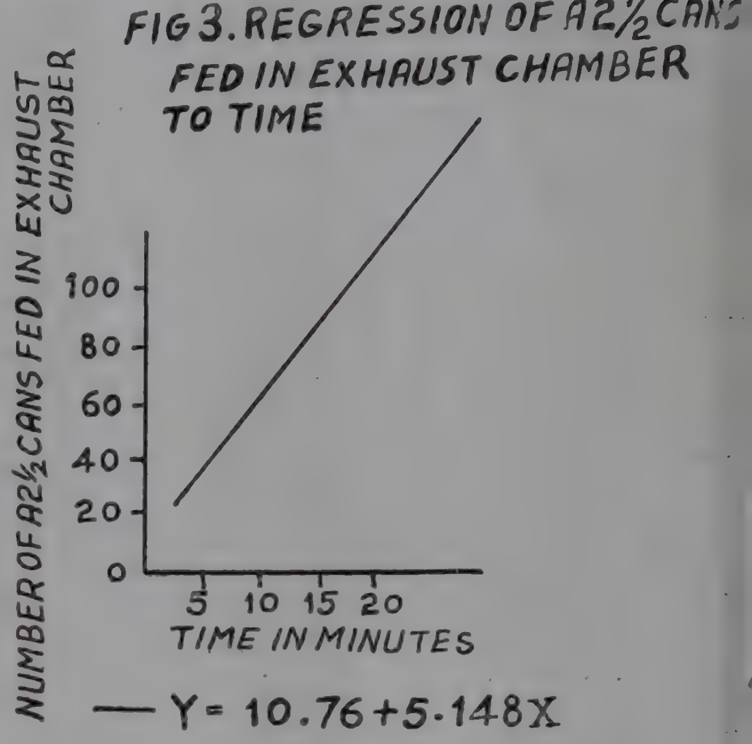
FIG 3. REGRESSION OF A2½ CANS FED IN EXHAUST CHAMBER TO TIME

2.11. 2 *Processing:* There are four retorts and each retort can take a crate (standard fill) of 110 A2½ cans and 198 butter cans. The expected turnover of a retort for factory day is approximately 1508 cans (A2½) or 3168 butter cans, i.e., 62-5/6 cases of A2½ cans and 88 cases of butter cans, on the assumption the crate is full everytime it is processed and that the average time for processing, loading, and unloading a retort is 35 minutes and 30 minutes for A2½ and butter cans respectively. Thus the four retorts are sufficient to cope with an optimum production of 251 1/3 cases of A2½ cans or 352 cases of butter cans. Normally in a factory day, 12 to 14 charges of each retort for A2½ and butter cans respectively are possible and so the normal capacity will be 220 cases A2½ cans or 308 cases butter cans.

The approximate time for the same crate to return to the seamer is 1 hour 30 minutes for A2½ and butter cans with the following break-up:

	A2½ cans	*Butter cans*
Time for filling the crate ...	20 mts.	25 mts.
Time for lifting and lowering in retort ...	3 ,,	3 ,,
Processing time ...	30 ,,	25 ,,
Time for lifting from retort and lowering in water tanks ...	2 ,,	2 ,,
Time kept in water tanks for cooling ...	25 ,,	25 ,,
Time for unloading and return to seamer ...	10 ,,	10 ,,
	1 hr. 30 mts.	1 hr. 30 mts.

In order that continuity of production be maintained *a minimum of 10 crates are necessary.*

3. Classification of returns and wastage: In the pineapple processing, the wastage is in the form of (*i*) juice spilling, (*ii*) crown and ends, (*iii*) peels, (*iv*) cores and pomace. The factory maintains production statistics of only the last three items and an estimate of the first was obtained by study of five samples of lots for processing (Table VII) while for others from production figures for 20 days the details of which are omitted for want of space.

3.1 *Crown and ends:* These constitute on the average 18.3 per cent of the input with a standard deviation of 1.34 per cent and 95 per cent confidence interval given by 15.65 per cent; 20.89 per cent.

3.2 *Peels:* These constitute on the average 29.7 per cent of the input with a standard deviation of 5.77 per cent and 95 per cent confidence interval given by 18.33 per cent; 40.97 per cent.

3.3 *Cores and pomace:* These constitute on the average 11 per cent of the input with a standard deviation of 2.19 per cent and 95 per cent confidence interval given by 6.67 per cent; 15.27 per cent.

3.4 *Juice waste in the form of spilling during different operations:* The loss of juice is as much as 5.8 per cent in over-matured fruit and is about 0.8 per cent in fruits of optimum maturity—out of which 0.6 per cent to 0.65 per cent can be accounted safely at peeling operation, i.e., it is as much as 60 lb. per every 10,000 lb. of input.

3.5 Wastage of solid materials accounts for nearly 59 per cent of the input, its removal is quite a serious problem. It is disposed of at present, from the processing zone, in baskets carried by two workers, to pits outside. The frequency of removal also gives a measure of the disturbance at different operations—peeling, punching, coring, etc., (please see Figure 4).

The interference could be minimised by reducing the collection points and the frequency of removal (please see Table VI).

FIG. 4. FREQUENCY OF WASTAGE CARRYING (REGRESSION OF WASTAGE ON INPUT)

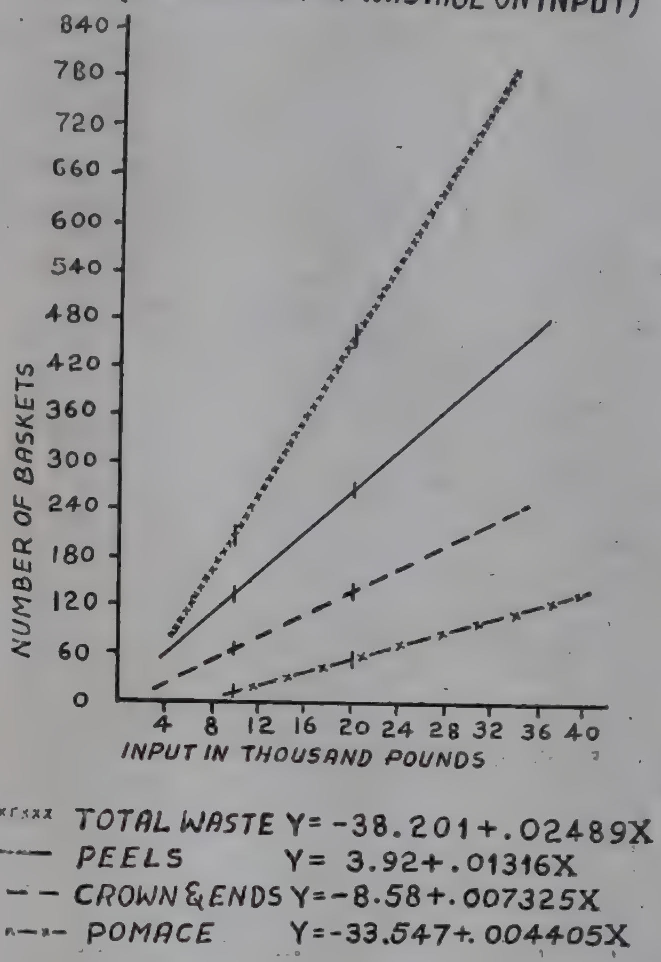

TABLE VI. *Distribution of time for wastage removal (in seconds)*

	From the peeling and punching zone to weighing machine	From the juice extractor to the weighing machine	Time for weighing a basket	From the weighing machine to the pit	For throwing in the pit
Average ...	21.63	25.52	7.85	37.43	6.25
Standard Deviation	6.492	3.412	2.489	6.535	2.739

3.6 The factory does not maintain data regarding the breakdown of the product at different stages of the production system. The fruits of different sizes were, therefore, sampled and the product at different stages measured, to provide a measure of the missing information of the production system as percentages of the input. The data in Table VII provides estimates as well as the correlation between the length and diameter of fruits.

There appears to be a linear relationship between diameter and length of fruit (Fig. 5). This suggests that the control of lengthwise

TABLE VII. *Particulars of productivity and wastage expressed as percentages in the five different samples of fruits and distribution of length and diameter of fruits in them*

	Sample No. 1	Sample No. 2	Sample No. 3	Sample No. 4	Sample No. 5	OVERALL
i	ii	iii	iv	v	vi	vii
No. of fruits in the sample	50	51	53	20	50	224
Average weight	6.20	3.00	4.75	10.05	7.20	5.695
Range in inches: Diameter	5.50″-6.25″	4.25″-5.25″	5.00″-6.25″	6.75″-7.50″	5.75″-6.50″	4.25″-7.50″
Length	6.00″-7.75″	4.25″-5.75″	5.75″-7.50″	8.50″-10.25″	6.75″-8.75″	4.25″-10.25″
Regression of length on the diameter of fruit	Y=5.40+ .2894X	Y=.660+ .9238X	Y=3.42+ .5717X	Y=10.48− .1771X	Y=2.46+ .8402X	Y= − 3.093+ 1.7525X
Weight of crowns and ends	11.94%	14.77%	11.91%	6.84%	9.44%	10.98%
Weight of fruit without crowns and ends	88.06%	85.23%	88.10%	93.16%	90.56%	89.02%
Weight of crowns and ends at slicing	5.16%	8.05%	6.94%	2.74%	3.61%	5.30%
Weight of peels	22.10%	21.14%	22.82%	20.52%	22.85%	21.89%
Weight of residual fruit after punching	27.58%	25.17%	26.59%	41.54%	29.03%	29.98%
Number of slices after punching: Big	423	22	272	232	464	
Small	93	306	118	8	77	
Overall	516	328	390	240	541	
Weight of slices after punching: Big	...	...	...	22.76%	27.29%	...
Small	...	...	...	0.37%	2.92%	...
Overall	32.42%	29.70%	30.95%	23.13%	30.11%	28.10%
Weight of slices after coring: Big	...	...	22.12%	19.28%	22.92%	...
Small	...	...	5.26%	.25%	2.43%	...
Overall	28.23%	24.83%	27.38%	19.53%	25.35%	24.09%
Weight of cores	4.19%	4.87%	3.57%	2.99%*	4.86%	4.10%
Weight of slices after trimming and before washing: Big	...	...	19.05%	17.66%	20.83%	...
Small	...	...	5.06%	0.25%	2.29%	...
Overall	25.48%	22.82%	24.11%	17.91%	23.13%	22.69%
Waste in trimming and coring	0.81%	0.67%	1.49%	0.75%	0.76%	0.90%
Weight of titbits upto trimming	1.94%	1.34%	1.79%	0.87%	1.46%	1.48%
Loss of juice due to spilling upto trimming operation	0.81%	1.18%	0.79%	5.85%	4.86%	...
No. of cans filled at washing: Big slices— A 2½	...	...	29	26	50	...
Small slices— A 2½	...	...	8	½ (part of a can)	5	...
Total ...	...	...	37	26½	55	...
Weight of titbits and washing	...	...	2.38%	...	...	...

* The difference in the weight of cores is accounted under juice spilling as, there was significant juice spilling due to over-ripe fruit.

growth of the fruit would also condition the average diameter suited for the optimum yield n silces.

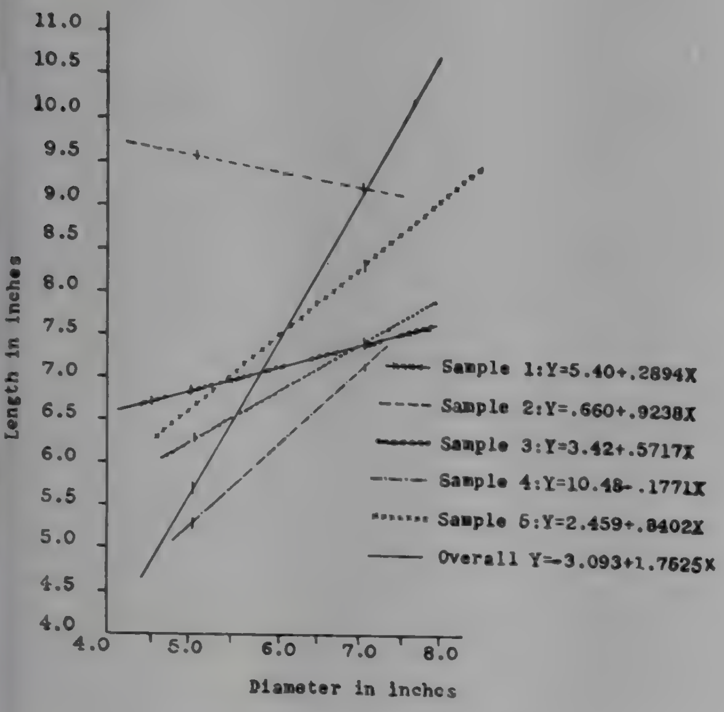

FIG. 5. Regression of length on diameter of fruits in five different samples

4. Efficiency of the present system

A sample evaluation of the efficiency of the system on two days is provided in Table VIII.* The table shows that the efficiencies of the operations like slicing, peeling (taking 3 at a time) coring, and washing range between 40 and 50 per cent while that of punching is between 35 and 40 and that of trimming between 55 and 60 per cent. The days selected being peak days on which the factory produced a huge quantity of the product—employing workers overtime—the table provides reliable indicators of the efficiencies attained at the major unit operaions in the existing system.

5. Discussion

This study reveals five major points which need attention.

5.1 *The ordering of fruit* for processing is not co-ordinated with production leading to lean and glut periods. In the former case it leads to slow and inefficient working, in the latter, spoilage and wastage due to stacking.

5.2 *Distribution of material:* The method of collection of slice leads to accumulation at the machine, the slices as they are fed from the slicer to the peeling table is in such a manner that the slices cut earlier are not removed for longer time.

The delivery of slices at peeling table,* the punched at coring table† and cored at trimming table, and trimmed at storage point near the washing table is such as to frequently disturb the worker from the unit operation. This is done in two ways, either by the roving worker who brings or removes the material or by the movement of the worker‡ doing a unit job to another type of work.

The removal of residual fruit is done by punching women themselves$ which means going to the crushing machine every few minutes. Every worker has two sets of punches and has to, as

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* Due to practical difficulties data on all aspects could not be collected at the same time and hence sample evaluation.

* The disturbance is about 15 seconds every 7 to 10 minutes per set of four workers. The amount of time wasted is, therefore, substantial.

† The interference due to roving collector of punched slices can be safely put as 2 to 3 seconds per worker every 15 minutes plus the intangible due to the break in continuity.

‡ It takes nearly 30 to 40 seconds for a worker to take the cores and dump it near the crusher and return back to work and the frequency of occurrence is at every 10 to 15 minutes with the result that a worker has to do it at least for 32 times a working day and the waste of time resulting in the same is about 15 to 20 minutes per worker which in terms of productivity loss works out to 320 to 425 effective slices per worker (about 30 to 40 A2½ slices cans per worker).

$ The punching woman takes approximately 15 seconds to crush the residual fruit in her tray—and 30 seconds to go to the crusher and return to work. The frequency of this is at every 15 minutes and the number of times in a day is not less than 32 for each worker, with the result that the minimum interference is as much as 24 minutes per worker due to this present practice.

At the instance of our suggestion the factory for a few days arranged the keeping of a big, aluminium vessel near the coring table where the women would deposit the cores which would be removed to the crusher from time to time as it gets filled. The practice resulted in saving as much as 15 minutes per worker per day and the management was only pleased to change over to the new practices.

TABLE VIII. *Evaluation of efficiencies of the present system on two sample days—when the production was peak—with reference to the standard work-load obtained by the study*

	Date 4-5-1961 Lot size 5607: weight 3,0000 lbs., Av. no. of slices per fruit-8				Date 6-5-61 Lot size 5933: weight 28,831 lbs. Av. no. of slices-8			
	No. of hours employed	Labour hours employed	Labour hours required as per *standard work-load*	Efficiency	No. of hours employed	Labour hours employed	Labour hours required as per *standard work-load*	Efficiency
Slicing	6	12†	5.377†	44.81†	8	12†	5.690†	47.42%
Peeling	16	192	78.28* 58.71‡	40.77%* 30.58%‡	13	156	82.83* 62.12‡	53.09%* 39.82%‡
Punching	18	216	75.64	35.02%	18	216	80.04	37.06%
Coring	7	84	35.14	41.83%	7	84	37.18	44.26%
Trimming	28	336	191.38	56.95%	28	336	202.51	60.27%
Washing and filling	12	144	59.81	41.53%	11	132	63.28	47.94%

† Hours of machine utilization. *Taking 3 slices at a time. ‡Taking 4 slices at a time.

NOTE: The efficiency at slicing is the efficiency of machine utilization.

she picks up the slice, judge its size and then change the punch according to the requirement. This introduces a break in the continuity of the operation. The emphasis being on the operations, considerable quantities of juice is allowed to go waste in peeling and punching and no effort is made to collect it.

5.3 *Wastage collection points and disposal:* The number of points of collection, method of removal and the number of workers engaged in it, affects work, hinders work and is not very efficient.

5.4 *Unit job:* A number of workers are required to do more than one job, such as punching or coring and removal of product and waste. The other type of differentiation which affects productivity is when a puncher and corer has to select the size of the slice or the punch or core.

5.5 *Furniture design and equipment:* The one exhaust chamber cannot cope with production at full swing and there is need for one more. Similarly, there is need for more crates for maintaining the continuity of production. The tables now being used are not conducive to efficient working nor is the present flow of production from one unit operation to another. There is a need for redesigning of the tables as well as as the realignment of the factory layout.

6. Suggestions for improvements

6.1 *Slicer:* The collection of slices from patented slicers should be in trays arranged on a revolving table near the slicer so as to enable the transport to the peeling table in *sequential* order* to avoid wastage of early cut slice.

6.2 The slices should be approximately classified into big and small in different trays so that slices of the same size may be delivered to a set of four peeling women at a time.

6.3 A peeling table as shown in *diagram Nos. 1 and 2* will be able to meet some of the shortcomings of the existing system. The table is made up of two smaller tables of dimensions $8' \times \frac{3}{4}'$ each interconnected by rods at distances $1'$ and $3\frac{1}{2}'$ from ends on either tables as shown by AB, CD, EF and GH in the diagram. On the

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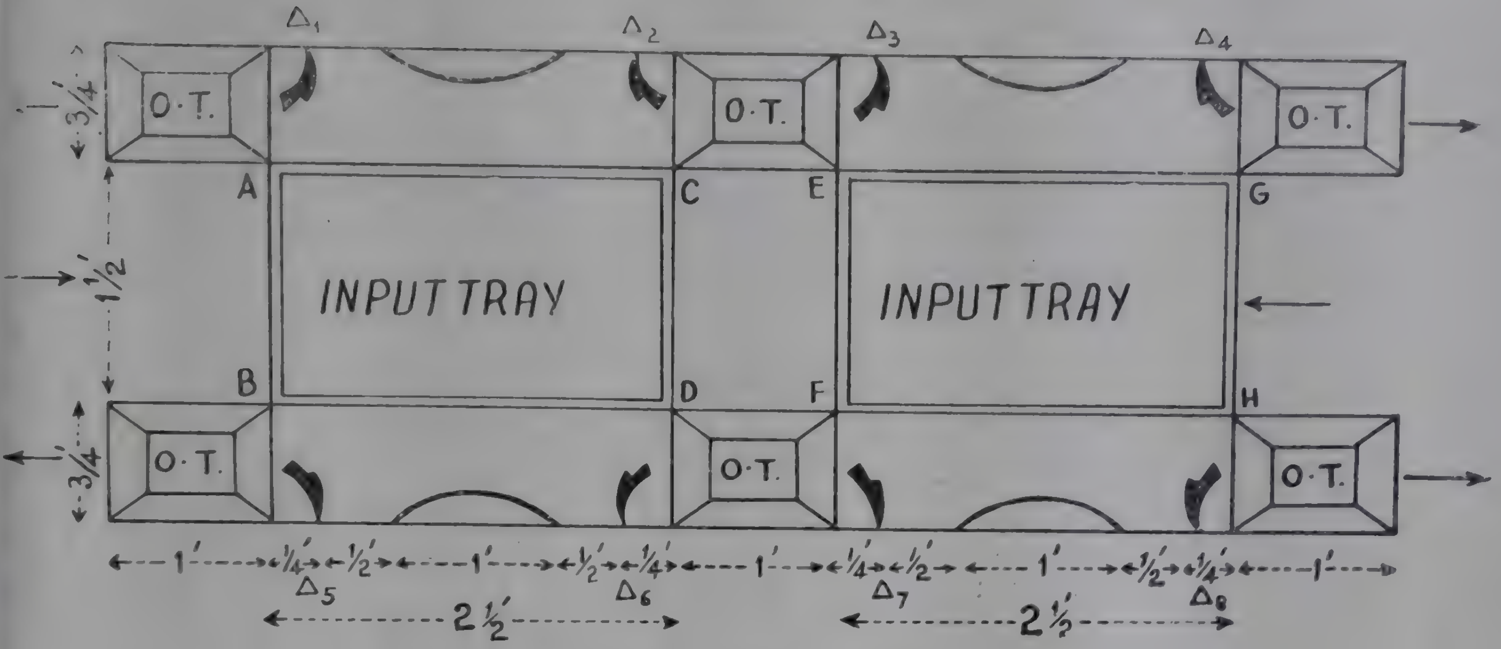
* Instead of revolving table, which has more facility, i is possible to collect the slices in trays from the slicer an arrange them in some sequential order on a table kep near by so that it may be transported to the peeling zon in the same order.


Δ1
Δ2
Δ3
Δ4
O·T.
O·T.
O·T.
O·T.
O·T.
O·T.
A
B
C
D
E
F
G
H
INPUT TRAY
INPUT TRAY
3/4′
1½′
3/4′
1′
¼′
½′
1′
½′
¼′
1′
¼′
½′
1′
½′
¼′
1′
Δ5
Δ6
Δ7
Δ8
2½′
2½′

Length of the table 8′ breadth 3′

Diagram No. 1. Peeling Table

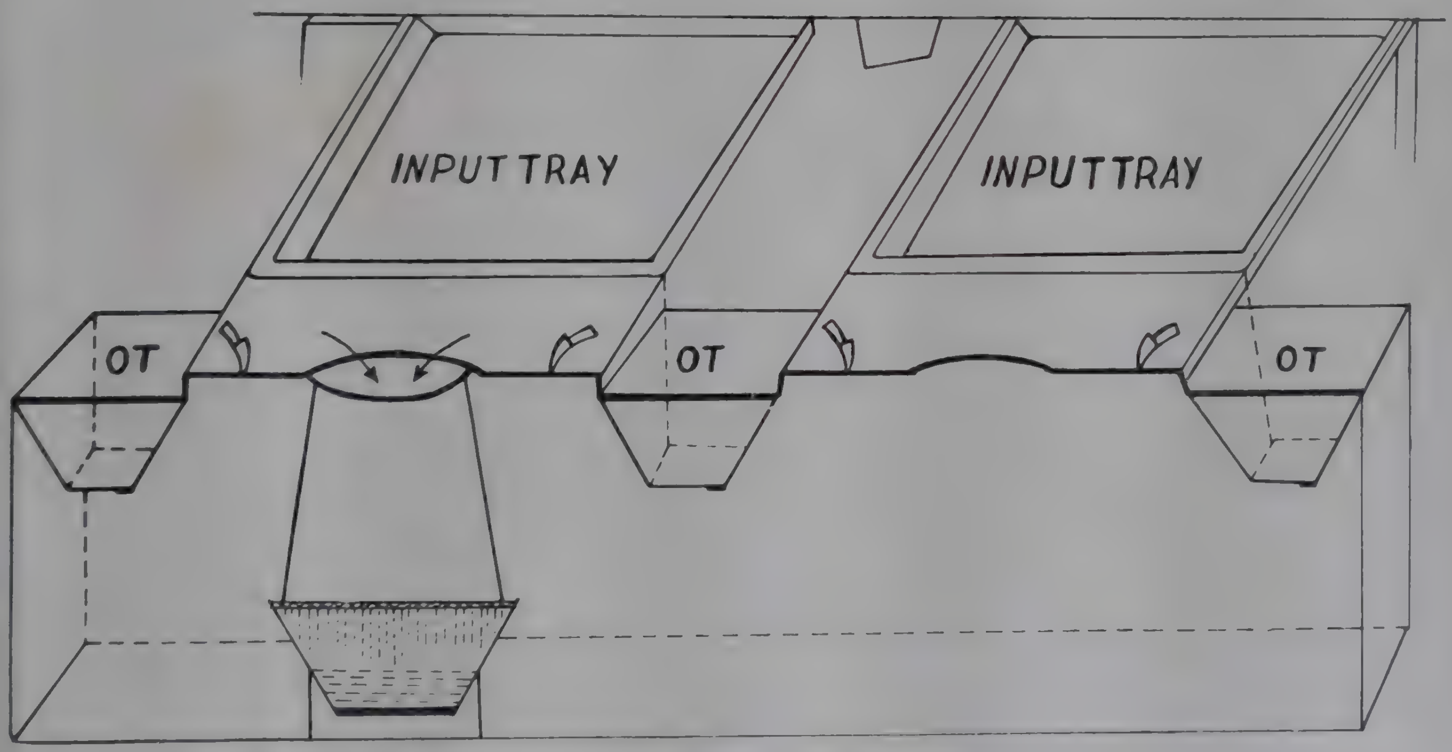

INPUT TRAY
INPUT TRAY
OT
OT
OT

Diagram No. 2. Peeling Table

rod AB and CD is kept the input tray (depth ¾″ to 1″)—where slices for peeling are delivered by a worker in small trays who takes the path through the empty space shown by arrows in the diagram. (The worker who delivers the slices for peeling, therefore, does not disturb the workers peeling the slices as in the existing system). The places denoted by OT in the diagram are *output trays* where the peeled slices could be arranged by peeler women duly sorted and which have opening at the ends shown by arrows. The collection of peeled slices can be done by a roving worker very easily from out of the trays OT in the tables through the openings and the same taken and delivered to punching women for different gauges. This has the additional advantage that collecting woman cannot disturb the peeling woman as in the existing system.

In between the knives $\triangle_1$, $\triangle_2$, $\triangle_3$, $\triangle_4$, $\triangle_5$, $\triangle_6$, $\triangle_7$, and $\triangle_8$, are openings on the table through which peels could be pushed by the worker which will slide on aluminium sheet to a sieve kept on a container below the table. The juice will be collected in the container while the peels will be in the sieve, which has collapsible opening at the opening ends of the table. The collection of the peels is done in baskets by the same path as the worker who distributes slices for peeling. Juice in the existing system gets spilled on the floor to the extent of approximately 60 lb. for every 10,000 lb. of production. And even if the production is as high as 40,000 lb. in a day, during a shift of 3 hours not more than 70 lb. of juice will get collected in all the containers kept for the purpose. Thus a small aluminium container will do for the purpose.

This table will solve the defects as enumerated under items 5.2 and 5.3 in effecting delivery of slices for peeling without disturbing the peelers facilitating classification of peeled slices into big and small slices, locating a waste collection point for every four workers below the table and providing extra space for movement in factory and as well facilitating collection of wasted juice at the peeling operation which can be processed for sale.

6.4 A punching and coring table as shown in the *Diagram No. 3* will eliminate the bottlenecks as referred under items 5.3 and 5.4.

The punching and coring table has the facility of trays in the table itself in the places denoted by S_i and R_i, $i=1, 2 \ldots$ in the diagram which stand for input tray and output tray respectively. The material for punching or coring is delivered in the input tray and the product after punching or coring is collected in the output tray which can be easily cleared by a roving worker from the opening shown by arrows in the output trays as also the material for coring can be delivered to the coring table through the openings shown by arrows in the input trays. In between the input and output trays is a raised platform W_i, $i=1, 2 \ldots$ on the table at the level of duct (or channel) in the middle of which is fixed a felt or a rubber of size 7″ × 7″ with arrangement to take the felt out and clean the table. On the felt is done coring or punching and the residual fruit or cores could be pushed into the channel in the middle so that the residual fruit or the cores could be collected in a container kept below the table periodically through the slanting aluminium sheet leading from the table to the container. Thus the interference due to residual fruit and cores in the clearance of it and as well of punched

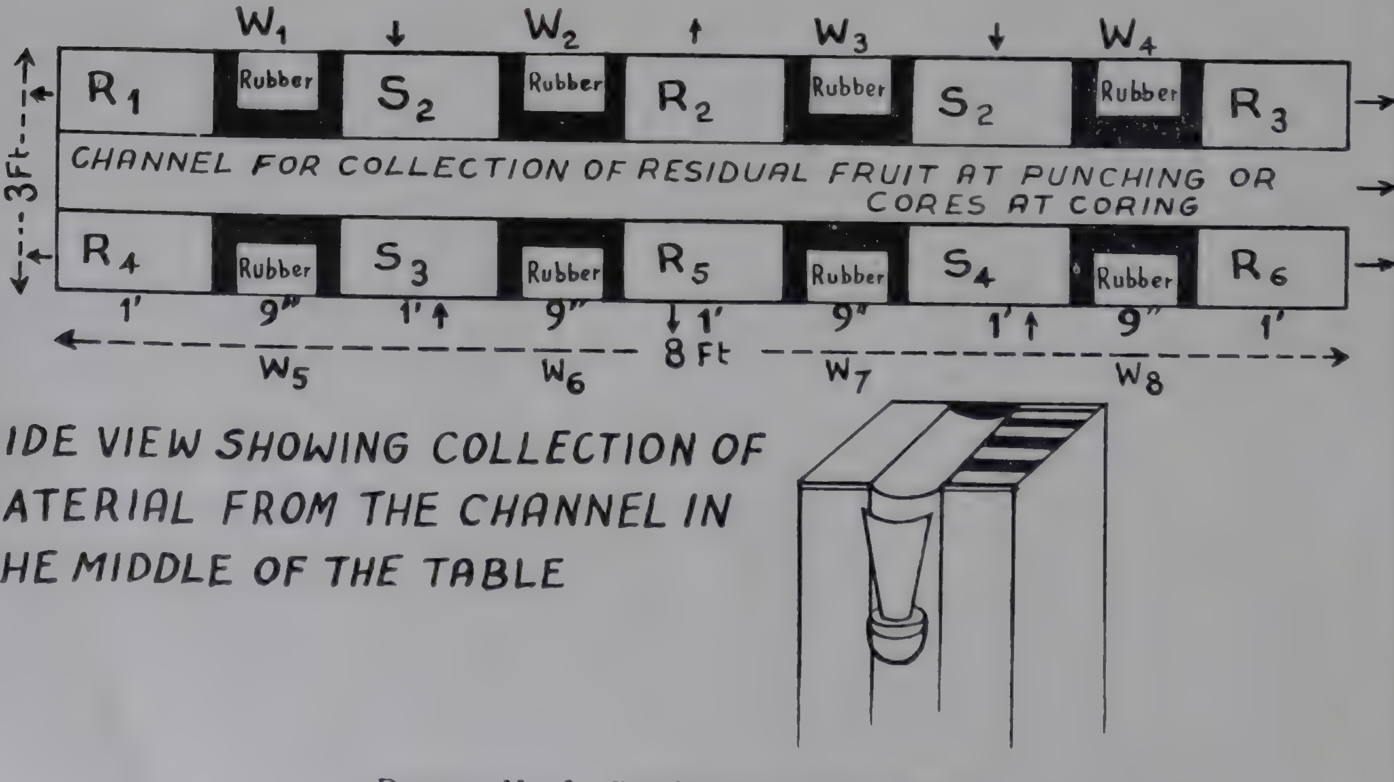

W1
W2
W3
W4
R1
Rubber
S2
Rubber
R2
Rubber
S2
Rubber
R3
CHANNEL FOR COLLECTION OF RESIDUAL FRUIT AT PUNCHING OR CORES AT CORING
3Ft
R4
Rubber
S3
Rubber
R5
Rubber
S4
Rubber
R6
1'
9"
1'
9"
1'
9"
1'
9"
1'
8 Ft
W5
W6
W7
W8
SIDE VIEW SHOWING COLLECTION OF MATERIAL FROM THE CHANNEL IN THE MIDDLE OF THE TABLE

Diagram No. 3. Punching and Coring Table nd cored slices in the delivery and clearance rom the trays in the existing system are eliminated in this table.

6.5 The classification of slices into small and big by the peelers envisaged in the altered system will facilitate distribution of slices of the same size at a time to the punching and coring women so that the frequency of changing the gauges too many times may be eliminated which incidentally effects a reduction in the idle time of the individual worker.

6.6 The present practice of carrying the trimmed slices on a single rod should be discouraged as (*i*) it is time consuming and very deficient in worker utilization as the number of slices carried on each round is small and (*ii*) also because the slices are likely to break in the process of gathering on the rod or during movement.

It is therefore felt that introduction of half round trays—each of which could accommodate 24 slices would, while stepping up worker utilization, could also reduce breakages.

6.7 Cores and residual fruit can be collected from the punching and coring table in containers arranged on a stool at the height of the platform of the trolley. The stool and the platform of the trolley will have two or three rows of moving pulleys so that a container with residual fruit or cores could be easily pushed from the stool to the trolley and vice versa by a single worker. The stool and the trolley can be designed to take a container of standard dimension so that the clearance of the same could be effected by a single worker from time to time.

The removal of wastage—peels and crowns and ends can also be done with trolleys, which can take at least two to three basketsful at a time. One trolley of the description with two workers operating and which can take two basketsful could very effectively clear the wastage of peels, crowns and ends. The utilisation of workers could be doubled and since it takes approximately two minutes for a pair of workers to take the waste from peeling zone to the pit and return approximately 480 basketsful, clearances could

TABLE IX. *Allocation of labour for different operations for varying number of fruits in different categories classified as per size in Table IV*

	Small fruit				Medium fruit				Big			
	1,000	2,000	5,000	10,000	1,000	2,000	5,000	10,000	1,000	2,000	5,000	10,000
crowning	1 (.21)	1 (.42)	2 (1.4)	3 (2.08)	1 (.21)	1 (.42)	2 (1.04)	3 (2.08)	1 (.21)	1 (.42)	2 (1.04)	3 (2.08)
eding the washing tank	1 (.22)	1 (.43)	2 (1.09)	3 (2.17)	1 (.22)	1 (.43)	2 (1.09)	3 (2.17)	1 (.22)	1 (.43)	2 (1.09)	3 (2.17)
eling †	2 (1.23)	3 (2.45)	7 (6.14)	13 (12.27)	2 (1.62)	4 (3.27)	9 (8.18)	17 (16.37)	3 (2.05)	5 (4.09)	11 (10.23)	21 (20.45)
‡	2 (1.64)	4 (3.27)	9 (8.18)	17 (16.37)	3 (2.18)	5 (4.37)	11 (10.92)	22 (21.83)	3 (2.73)	6 (5.45)	14 (13.62)	28 (27.25)
nching	2 (1.58)	4 (3.16)	8 (7.90)	16 (15.80)	3 (2.11)	5 (4.21)	11 (10.53)	22 (21.05)	3 (2.63)	6 (5.26)	14 (13.16)	27 (26.34)
oring	1 (.73)	2 (1.47)	4 (3.67)	8 (7.34)	1 (.98)	2 (1.96)	5 (4.90)	10 (9.80)	2 (1.22)	3 (2.45)	7 (6.12)	13 (12.24)
rimming	4 (4)	8 (8)	20 (20)	40 (40)	6 (5.32)	11 (10.64)	27 (26.60)	54 (53.19)	7 (6.67)	14 (13.33)	34 (33.33)	67 (66.67)
ashing and illing	2 (1.25)	3 (2.50)	7 (6.25)	13 (12.50)	2 (1.67)	4 (3.33)	9 (8.33)	17 (16.67)	3 (2.08)	5 (4.17)	11 (10.42)	21 (20.83)

† Taking 4 slices at a time. ‡ Taking 3 slices at a time.

NOTE: The figures in brackets give exact theoretical requirements at work-load assignment of 80 per cent of "Standard" for each operation.

TABLE IX. *Continued*

	Giant				Colossal			
	1,000	2,000	5,000	10,000	1,000	2,000	5,000	10,000
Decrowning	1 (.21)	1 (.41)	2 (1.04)	3 (2.08)	1 (.21)	1 (.42)	2 (1.04)	3 (2.08)
Feeding the washing tank	1 (.21)	1 (.43)	2 (1.09)	3 (2.17)	1 (.22)	1 (.43)	2 (1.09)	3 (2.17)
Peeling	* 3 (2.46)	5 (4.92)	13 (12.29)	25 (24.57)	3 (2.87)	6 (5.73)	15 (14.33)	29 (28.65)
	† 4 (3.27)	7 (6.54)	17 (16.34)	33 (32.68)	4 (3.81)	8 (7.63)	20 (19.08)	39 (38.17)
Punching	4 (3.17)	7 (6.33)	16 (15.82)	32 (31.65)	4 (3.69)	8 (7.38)	19 (18.45)	37 (36.90)
Coring	2 (1.47)	3 (2.94)	8 (7.34)	15 (14.68)	2 (1.71)	4 (3.43)	9 (8.56)	18 (17.12)
Trimming	8 (8)	16 (16)	40 (40)	80 (80)	10 (9.35)	19 (18.69)	47 (46.73)	94 (93.46)
Washing and filling ...	3 (2.50)	5 (5.0)	13 (12.50)	25 (25.0)	3 (2.92)	6 (5.83)	15 (14.58)	30 (29.16)

* Taking 4 slices at a time. † Taking 3 slices at a time.

be done by a trolley in a factory day. Assuming the work-load at 80 per cent of the standard, a pair of workers could clear the waste arising out of a production upto 20,000 lb. of input, provided the peeling zone is located in the same place as at present.

The peeling zone if it were to be locate opposite the reforming room at present, nearl 640 basketsful clearances of waste could be don in a day by a pair of workers operating a trolle and therefore they would be able to operate fo a production of approximately 25,000 lb.

TABLE X. *Showing the efficiencies required to be obtained by individual workers for doing the work as per allocation of labour in Table IX*

No. of fruits	Peeling					Punching					Coring				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
1,000	% *49 ‡65	% *66 ‡58	% *55 ‡73	% *65.5 ‡65.3	% *76.1 ‡76.3	% 63.2	% 56.1	% 70.2	% 53.3	% 73.8	% 58.7	% 78.3	% 49.0	% 58.7	% 68.5
2,000	*65 ‡66	*66 ‡70	*66 ‡73	*78.6 ‡74.6	*76.4 ‡76.3	63.2	67.3	70.2	72.3	73.8	58.7	78.3	65.3	78.3	68.5
5,000	*70 ‡73	*73 ‡79	*74 ‡78	*75.6 ‡76.6	*76.4 ‡76 3	79.0	76.6	75.2	79.1	77.7	73.4	78.3	70.0	73.4	76.1
10,000	*76 ‡77	*77 ‡78	*78 ‡78	*78.6 ‡79.2	*79.0 ‡78.2	79.0	76.6	78.0	79.1	79.8	73.4	78.3	75.3	78.3	76.1

* Taking 4 slices at a time. ‡ Taking 3 slices at a time.
A = Small. B = Medium. C = Big. D = Giant. E = Colossal.

TABLE X. *Continued*

o. of fruits	Trimming					Washing and filling				
	A	B	C	D	E	A	B	C	D	E
1,000	80.0%	70.9%	76.2%	80.0%	74.8%	50.0%	66.7%	55.5%	66.7%	77.7%
2,000	80.0%	77.4%	76.2%	80.0%	78.7%	66.7%	66.7%	66.7%	80.0%	77.7%
5,000	80.0%	78.8%	78.4%	80.0%	79.5%	71.4%	74.1%	75.8%	76.9%	77.7%
10,000	80.0%	78.8%	79.6%	80.0%	79.5%	76.9%	78.4%	79.4%	80.0%	77.7%

6.8 In case the factory launches a pro- ramme of expanding business, addition of one ore exhaust box, two retorts, five crates, one lditional seamer working and one more cooling nk, will help the factory to cope with a production nearly 40,000 lb. of fruit in a factory day. his is possible provided the present boiler can ive sufficient steam to all 6 retorts, two exhausts, vo kettles and one heat exchanger, operating the same time and the prepared material is ready, which is possible by increasing labour strength, addition of one more slicer, crusher and hydraulic press. With the present set-up, the factory will not be able to cope with the production of more than 23,000 lb. in a factory day assuming present processing procedure is maintained. Introduction of spin-pasteurisation technique for processing will alter the set up as the time required for processing is not more than two minutes for slices and juice.

TABLE XI. *Experimental channels—efficiency of working*

	Experimental channel No. I Lot size 503 fruits Average weight 5.2 lbs.			*Experimental channel No. II* Lot size 722 fruits Average weight 3.43 lbs.		
	Labour hours required	Theoretical requirement at specified standards	Efficiency	Labour hours required	Theoretical requirement	Efficiency
ecrowning	1.20	.668	56%	1.33	.959	72%
licing	4.00*	2.984	75%	2.67	1.582	55%
eeling	11.33	5.267† 7.022‡	46.4%† 62.0%‡	14.50	5.668† 7.560‡	39%† 52%‡
unching	11.33	6.786	60%	14.16	7.302	52%
oring	6.08	3.152	52%	6.58	3.393	52%
rimming	21.67	17.170	79%	16.67	18.483	110%$
Vashing	5.63	5.365	95%	...	...	...
utput	A 2½ Big slices. A 2½ Small slices.	Cans 273 Cans 107	Total 380	A 2½ Big slices. A 2½ Small slices.	Cans 71 Cans 214	Total 285

N.B.—The fruit is classified as medium in experimental channel No. 1—where the number of effective slices per fruit is 8; and as small in experimental channel No. 2—where the number effective slices per fruit is 6.

† Taking 4 slices at a time. ‡ Taking 3 slices at a time. * Work done on patent machine.

$ The working efficiency was more than the standard, since the fruit was small and did not require trimming at all for major portion of slices.

7. Allocation of work-loads

It is suggested that work-loads at norm of 80 per cent of the standard be assigned to workers during factory working. This can be achieved by allocation of labour to the work according as the fruit and the quantity thereof. Following the classification of fruit adopted in Table IV, the lot for processing during the day should be sampled for assessing the proportion of different classes of fruits in the lot getting which, from Table IV the number of workers required for each operation at 80 per cent efficiency, can be calculated as follows:

Example: Suppose the number of fruits is 10,000 and the proportion of small: medium: big: 2:3:4 and suppose the number of workers required at peeling taking 3 slices at a time is to be estimated, we have, from Table IV, that for every $\frac{(611 \times 2) + (458 \times 3) + (367 \times 4)}{10}$ = fruits, a worker is required.

Therefore, for 10,000 fruits of the lot a *minimum* of 25 workers are required.

Similarly, for other operations (*viz.*, punching, coring, trimming and washing), the requirement of labour can be calculated.

It is to be noted that as the number of fruits processed during the day is increased, the loss of efficient utilisation of labour due to the increase in the allocation of labour by one worker (resulting from rounding off the required number to the next figure) is minimised, so that the allocated numbers would secure approximately 80 per cent efficiency for fruits numbering 5,000 and more

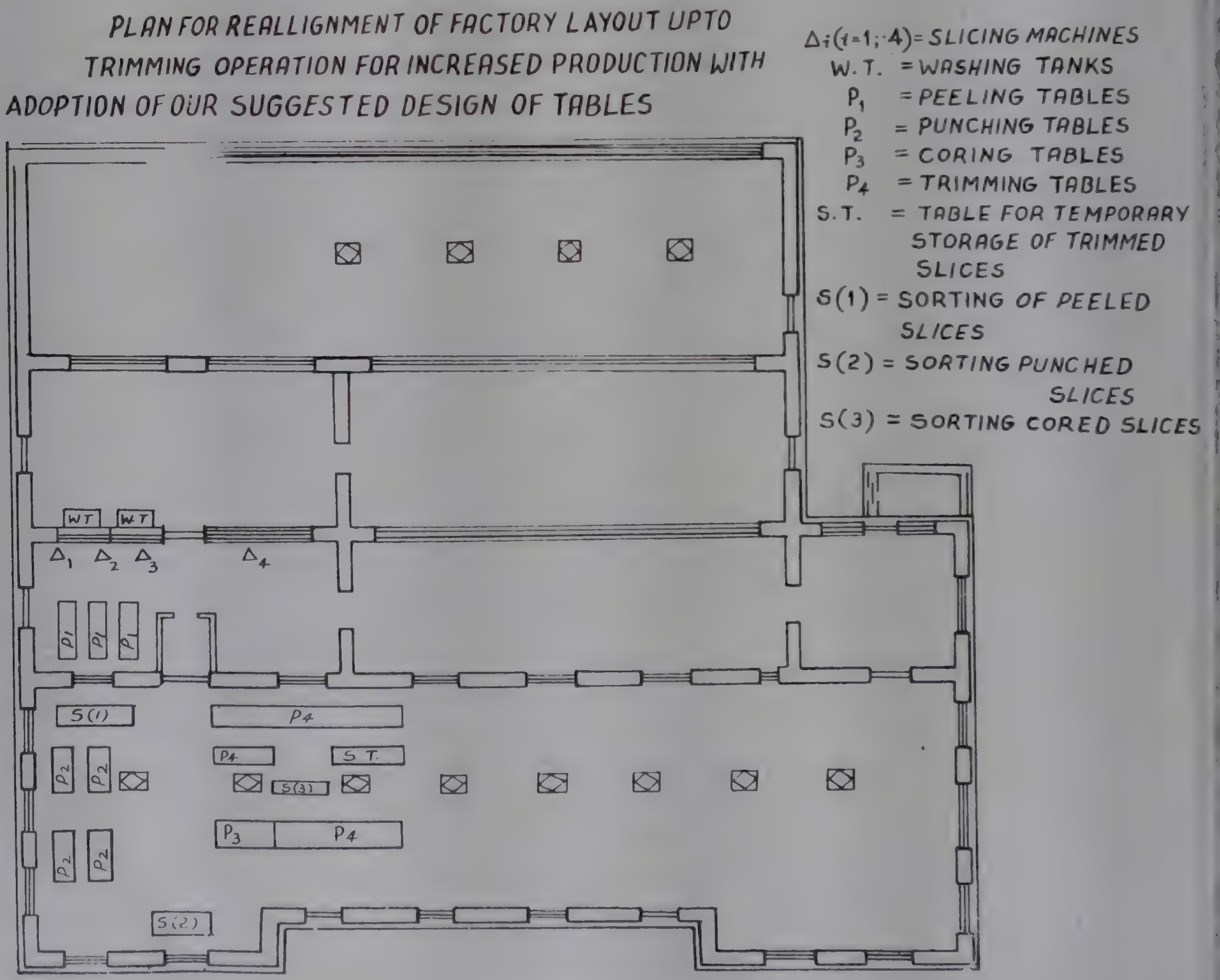

PLAN FOR REALLIGNMENT OF FACTORY LAYOUT UPTO TRIMMING OPERATION FOR INCREASED PRODUCTION WITH ADOPTION OF OUR SUGGESTED DESIGN OF TABLES
Δi(i=1;·4)= SLICING MACHINES
W.T. = WASHING TANKS
P1 = PEELING TABLES
P2 = PUNCHING TABLES
P3 = CORING TABLES
P4 = TRIMMING TABLES
S.T. = TABLE FOR TEMPORARY STORAGE OF TRIMMED SLICES
S(1) = SORTING OF PEELED SLICES
S(2) = SORTING PUNCHED SLICES
S(3) = SORTING CORED SLICES
WT
W.T
Δ1
Δ2
Δ3
Δ4
P1
P1
P1
S(1)
P4
P4
S T.
P2
P2
S(3)
P3
P4
P2
P2
S(2)

Diagram No. 4

vhile for smaller number there may be loss in fficiency, especially in operations like coring Tables IX and X.)

8. Experimental channel

After collection of the data during the last week of the study at the factory—an attempt to produce small lot size of fruit with allocations of labour set by us showed that an efficiency at the major operations between 50 per cent and 75 per cent could be easily realised with allocation of labour as per standards obtained by the study. At the peeling stage, the slices for peeling were delivered in small trays—they being collected in trays at the slicers as per suggestion in 6.1. Since projection of conditions of altered system were tried to be obtained by partial modification of a part of the existing system, ideal conditions were not obtained for the evaluation of the working of the altered system at peeling stage. The additional disadvantage was the unfamiliarity and sudden change in the practices from those to which the workers were used.

At the punching and coring stages the residual fruit or the cores were directed to be dumped in a container kept near the table and in punching one of the workers was specially assigned the job of smashing to bits the residual fruit obtained in punching. It was noted that the material for peeling could be very easily delivered from

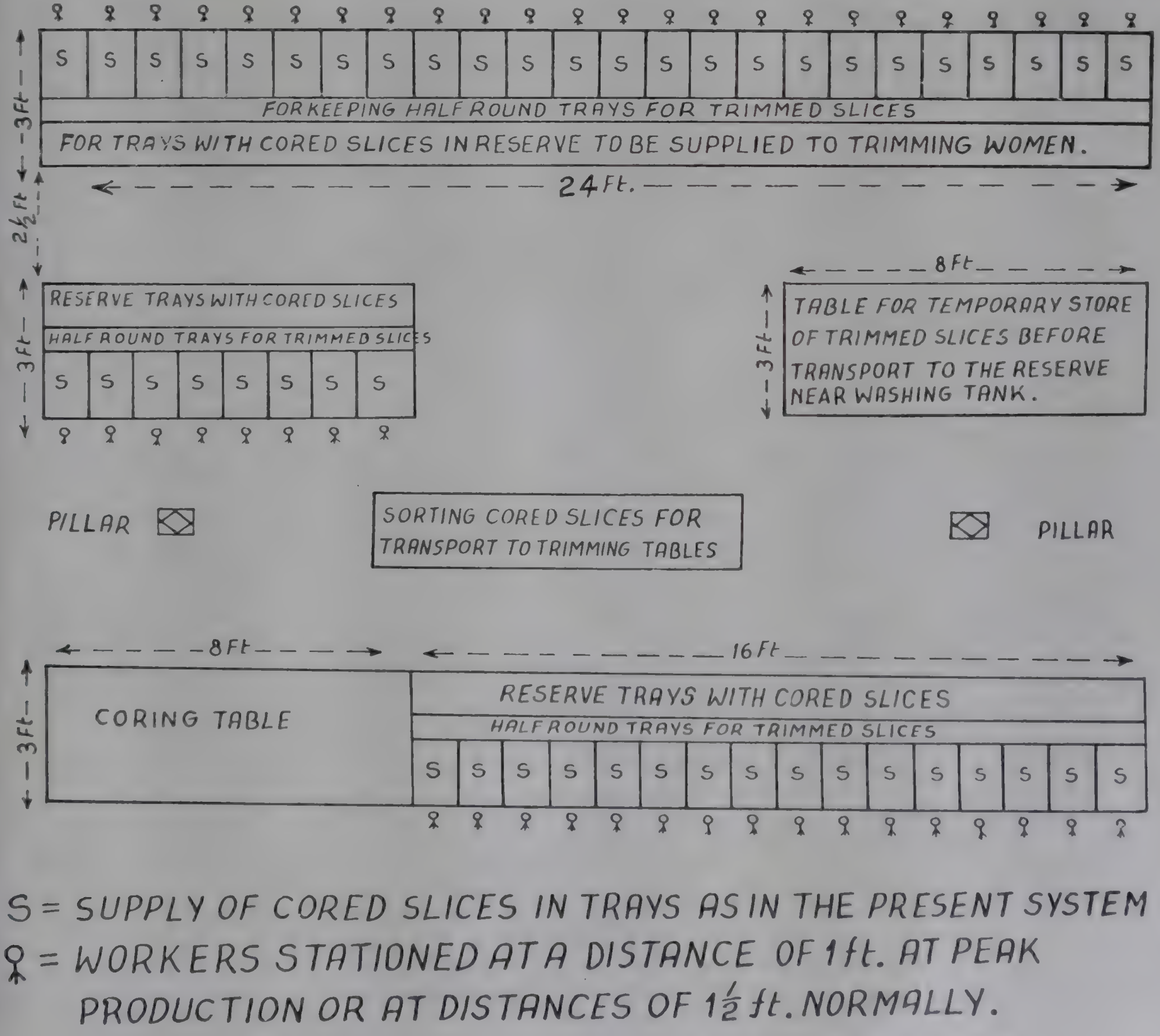

S
FOR KEEPING HALF ROUND TRAYS FOR TRIMMED SLICES
FOR TRAYS WITH CORED SLICES IN RESERVE TO BE SUPPLIED TO TRIMMING WOMEN.
3 Ft
24 Ft.
2½ Ft
RESERVE TRAYS WITH CORED SLICES
HALF ROUND TRAYS FOR TRIMMED SLICES
8 Ft
TABLE FOR TEMPORARY STORE OF TRIMMED SLICES BEFORE TRANSPORT TO THE RESERVE NEAR WASHING TANK.
PILLAR
SORTING CORED SLICES FOR TRANSPORT TO TRIMMING TABLES
PILLAR
8 Ft
16 Ft
CORING TABLE
RESERVE TRAYS WITH CORED SLICES
HALF ROUND TRAYS FOR TRIMMED SLICES
S = SUPPLY OF CORED SLICES IN TRAYS AS IN THE PRESENT SYSTEM
♀ = WORKERS STATIONED AT A DISTANCE OF 1 ft. AT PEAK PRODUCTION OR AT DISTANCES OF 1½ ft. NORMALLY.

DIAGRAM No. 5. An ideal disposition of workers and equipment on trimming tables in the proposed layout of the factory

TABLE XII. *The distribution of weight of fruit at different stages in the fruit used for processing during experimental channel*

	Experimental Channel No. 1	Experimental Channel No. 2
Lot size	503	722
Weight in lbs.	2,642	2,476
Average weight in lbs. ...	5.25	3.43
Weight of peels ...	25.10%	19.97%
Weight of crowns and ends	17.13%	19.30%
Weight of fruit without crowns and ends ...	84.39%	82.30%
Weight of residual fruit at punching which goes for crushing	23.19%	26.01%
Waste at coring and trimming	...	0.79%
Weight of cores ...	3.472%	3.29%
Tit Bits		
Trimming	1.45%	1.54%
Washing	2.45%	2.65%
Total	3.90%	4.19%

the slicer, collection being made in trays and the peelers were receiving supply without interruption in their work. It is opined that a single worker will be able to supply slices from a slicer to trimming table without interruption in the work of peeling—though in the experimental channel the slices could not be delivered without disturbing the peeler women as envisaged in the altered system by virtue of the fact that the design of peeling tables are totally different from the existing ones. Tables XI and XII provide the information obtained in the work of experimental channel.

9. Suggestion for factory layout

The study reveals that major incidence of wastage is at decrowning and peeling stages—almost amounting to 50 *per cent of the input.* If the location of peeling tables and decrowning zone is outside the processing hall, the question of movement in the processing hall *will be minimised* to the extent of (*i*) removal of the pomace to the pits after crushing for juice and (*ii*) the juice collected at the peeling tables as per the suggested altered design, which would be as many times as shifts in a day from the peeling tables. With this in view and with a view to gear the factory-layout for increasing production in the light of the suggested altered design of tables, it is suggested that the realignment of working units of the factory as per *Diagram No. 4.* Also, in the existing system there is crowding around trimming table so that supervision of work and supply of cored slices and movement of finished product is very much hindered. The deployment of labour at trimming table is suggested as the layout in *Diagram No. 5.*

In addition, introduction of gradual sloping of the path is suggested wherever steps are at present located in order that the movement of machines and men could be easily facilitated in the factory area, e.g., the steep steps from the outer hall leading to the pits are rather strenuous to climb or to get down and a smooth incline instead would facilitate easier movement of workers as well as that of trolleys.

The introduction of sloping will facilitate quick movement of cans from near the cooling tanks to the store in trolleys as per design and as well of waste from processing zone to the pits.

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STUDIES ON FACTORS AFFECTING THE SHELF-LIFE OF EDIBLE PEANUT CAKE, GRITS AND FLOUR

M. Kantharaj Urs, V. R. Srinathan, H. B. N. Murthy, M. Muthu and G. S. Bains

(*Central Food Technological Research Institute, Mysore*)

Considerable progress has been made in ecent years, in the utilization of peanut meal in he preparation of processed protein-rich foods[1,2] suitable for use in the prevention and treatment of protein malnutrition. The preparation of edible quality screw press peanut flour containing about 45-50 per cent protein and 7-9 per cent esidual oil has been described elsewhere by Subrahmanyan[3] *et al.* The effect of storage on the chemical composition and nutritive value of peanut flour stored in jute bags has also been studied by Subrahmanyan[4] *et al.* The effectiveness of anti-oxidants and maize flour in the prevention of oxidative rancidity in commercial peanut cake, has been reported by Xabregas *et al*[5].

In recognition of the scope that exists for the utilization of edible peanut flour in various protein rich formulations, the UNICEF have donated two 10 ton plants for its production in the country. Under this programme, it has been envisaged to organize the production in a central place and have the product distributed over neighbouring areas.

In view of the large production, some quantities of the peanut cake (both as grits and flour) are likely to be in storage for different periods under varying conditions. The present paper deals with the studies undertaken to evaluate the shelf-life of peanut flour, cake and grits under varying storage conditions.

Material and Methods

Peanut cake: obtained from the screw press using decuticled (blanched) kernels[3].

Peanut grits: obtained by lightly crushing the press cake.

Peanut flour: obtained by finely crushing the cake. The degree of fineness of flour was such that 95 per cent by weight passed through IS sieve 70 (equiv. ASTM 25 or BS 22) and not less than 80 per cent by weight passed through IS sieve 50 (equiv. ASTM 35 or BS 30).

Packaging: Polyethylene (250 gauge) as a loose liner in jute bag (size 20″ × 23″); polyethylene laminated jute bag (hessian, paper and polyethylene). The capacity of the bag was 12.4 kg. for flour and grits and 10.5 kg. for cake; tin containers (4. gl.) with a capacity to hold 15.0 kg. of flour and 12.0 kg. of grits and cake.

Moisture adjustment: The freshly prepared samples of flour, grits and cake had an average moisture content of 6.7 per cent at which they were stored in various containers. However, in another set of flours, the moisture content was raised to 9 and 11 per cent respectively, the latter being confined to storage in tin containers.

Antioxidant treatments: A mixture of BHA and BHT was incorporated into peanut flour only at a level of 0.01 per cent each on fat basis.

Fumigation: A mixture of ethylene dibromide and methyl bromide (1:3 w/w) at the rate of 3 lbs. per 1000 cubic feet and an exposure period of 48 hours, was used for fumigating the stocks in a 200 cubic feet atmospheric vault at an ambient temperature of 74-76°F. *Tribolium castaneum* adults (4-5 weeks old) and 3rd to 4th instar larvae of *Trogoderma granarium* were placed inside the tins at random as test insects and mortality counts were taken immediately after fumigation.

The fumigated material was aerated for a week before repacking in appropriate containers.

Conditions of storage: 100°F with 90 per cent relative humidity and 80°F with 60-70 per cent R.H.

Periodicity of examination: The samples stored at 100°F were examined at intervals of 6, 12 and 18 weeks; those stored at 80°F were examined after 20 weeks.

Nature of examination

Organoleptic evaluation: A taste panel of 12-16 members evaluated the materials on the basis of odour and taste. The samples were rated on a hedonic scale of 10 as follows:

Score:

10—Excellent, fresh taste and odour
8—Good, no off-taste and odour
6—Fair, slight off-taste and odour
4—Poor, marked off-taste and odour
2—Very poor, offensive taste and odour.

The test samples were presented for comparison along with a standard sample whose rating was fixed at 10. The standard sample was stored at 35°F in air-tight tin containers. Representative samples were taken from duplicate containers for each series of evaluation.

Colour: The colour of the grits and the flour was measured in a photo-electric reflection meter using the tristimulus green filter.

Chemical examination: Moisture and free fatty acid were determined by A.O.A.C. methods.

The lipase activity of the stored samples was measured by using olive oil emulsion as the substrate: 0.01 g. of defatted material was reacted with 10 ml. of olive oil emulsion (prepared by mixing 2 ml. of olive oil with 200 ml. of distilled water in a Waring blendor for 5 minutes) and 5 ml. of McILvaine's citric acid—di-sodium phosphate buffer of pH 8.0 for 4 hours with constant shaking at room temperature (27 ± 2°C). The reaction was stopped by addition of 30 ml. of alcohol-acetone mixture (1:1) and the free fatty acids were titrated with 0.05 N NaOH, using phenolphthalein as the indicator. The activity has been expressed as ml. of 0.1 N NaOH/g. of the defatted material under the above experimental conditions.

Oxidative rancidity was determined using Kreis test according to the procedure of Pyke[6] with slight modifications. 5 g. of the material was defatted with petroleum ether; the solvent was evaporated off and the residual oil weighed and dissolved in 1.5 ml. acetone, centrifuging off any precipitate, if present. The colour was developed with 2.5 ml. of 1 per cent phloroglucinol solution in acetone and two drops of concentrated sulphuric acid, the final volume being made up to 5 ml. in each case with acetone. Optical density was measured exactly after 30 minutes using Klett-Summerson photo-electric colorimeter (540 mμ filter).

Fumigant residues in the samples were determined as bromide according to the method of Young *et al.*[7]

TABLE I. *Organoleptic evaluation of peanut flour, grits and cake stored at 100° F and 90% R. H.*

Treatments		Average score (maximum score 10)								
	Package	Polyethylene loose liner			Polyethylene laminated bag			Tin		
	Storage in weeks	6	12	18	6	12	18	6	12	18
1. Flour—6.7% initial moisture		3.1	4.5	3.8	6.0	5.5	4.1	8.4	7.3	6.7
2. —do— + fumigation		5.6	6.0	4.0	6.3	5.8	3.7	8.0	7.3	5.7
3. Flour + antioxidant		6.4	6.6	4.4	7.0	6.9	4.2	7.9	7.7	6.2
4. Flour + fumigation + antioxidant		4.7	5.6	4.7	7.4	6.9	4.5	7.0	7.5	6.3
5. Flour—9% initial moisture		5.6	4.5	3.7	5.7	6.3	—	7.9	7.1	4.8
6. Flour—11% initial moisture		—	—	—	—	—	—	6.9	4.5	3·0
1. Grits—6.7% initial moisture		4.3	5.4	5.1	6.1	6.0	5.1	9.0	7.2	6.8
2. —do— + fumigation		6.8	6.0	4.6	7.9	5.9	4.6	8.1	7.4	6.3
1. Cake—6.7% initial moisture		5.0	5.7	5.8	7.3	6.8	5.7	—	7.5	6.5
2. —do— + fumigation		5.3	6.2	6.0	6.7	7.0	5.7	7.8	7.5	7.0

ABLE II. *Organoleptic evaluation of peanut flour, grits and cake stored at 80° F and 60-70% R.H. for 20 weeks*

Treatments	Average score (maximum score 10)		
	Polyethylene loose liner	Polyethylene laminated bag	Tin
Flour—6.7% initial moisture ...	8.0	8.0	7.1
,, + fumigation ...	8.0	7.3	8.0
Grits—6.5% initial moisture ...	8.4	7.8	8.0
,, + fumigation ...	8.4	7.8	—
Cake—6.4% initial moisture ...	8.3	8.0	8.2
,, + fumigation ...	7.8	7.7	7.8

Results and Discussion

The results of organoleptic evaluation ndicate that of the three types of containers used, tin container is the best for long storage followed by laminated jute bag and the polyethylene loose lined jute bag. Although both the laminated jute bag and polyethylene loose lined bag were found to afford necessary protection against ingress of moisture (Table III) even under accelerated conditions of storage the former affords better protection against external odour. Also from consideration of cost and ease of handling, laminated bag would be preferred to the tin container. The cake and grit samples were rated (Tables I and II) better than flour stored under similar conditions. Since cake occupies about 25 per cent more space, weight for weight, than grits and flour, it is more economical to store the processed cake as grits in preference to flour which tends to deteriorate faster.

No noticeable change in the colour of various stored samples was observed (Table IV) except slight decrease in the whiteness of peanut flour sample having 11 per cent moisture.

The fumigation and antioxidant treatments were found to have no adverse effect on the organoleptic quality of the samples. Fumigant residues were as follows:

Flour—27 ppm., grits 23 ppm. and cake 21 ppm. of inorganic bromide. These values are well within the permissible limits of 50 ppm. The samples remained practically free from visible insect infestation, though slight infestation was noticed only in the samples packed in polyethylene loose liner stored at 80°F and 60-70 per cent R.H., probably due to cross infestation.

The FFA of samples increased during storage (Table V), grits and the cake showing less increase as compared to flour. There was a relatively greater increase in FFA of samples having high initial moisture content. This observation emphasises the necessity of packing the material at a moisture content not exceeding 7-8 per cent. The development of FFA was less in samples stored at 80°F (Table VI).

TABLE III. *Percentage moisture content of peanut flour, grits and cake during storage at 100°F and 90% R.H.*

Treatments	Package	Polyethylene loose liner			Polyethylene laminated bag			Tin		
	Storage in weeks	6	12	18	6	12	18	6	12	18
1. Flour—6.7% initial moisture ...		6.8	7.2	7.5	6.8	7.5	7.6	—	6.7	6.4
2. ,, + fumigation ...		7.2	7.3	7.6	7.1	7.4	7.5	—	6.7	6.5
3. Flour + antioxidant ...		7.3	7.6	7.5	7.4	7.5	7.7	—	6.7	6.6
4. Flour + fumigation + antioxidant ...		7.2	7.4	8.3	7.1	7.2	7.7	—	6.7	—
5. Flour — 9% initial moisture ...		9.2	9.5	9.6	9.1	9.5	—	—	9.0	—
6. Flour—11% initial moisture ...		—	—	—	—	—	—	—	11.0	11.1
1. Grits—6.7% initial moisture ...		7.1	7.4	7.8	6.8	7.1	7.6	—	6.5	6.4
2. ,, + fumigation ...		7.3	7.4	7.6	7.1	7.4	7.7	—	6.5	6.8
1 Cake—6.7% initial moisture ...		6.8	7.2	7.9	6.7	7.1	7.4	—	6.4	6·4
2. ,, + fumigation ...		7.2	7.2	7.9	7.1	7.2	7.8	—	6.4	6.7

TABLE IV. *Colour of peanut flour and grits stored at 100° F and 90% R. H.**

Treatments	Package	Polyethylene loose liner			Polyethylene laminated bag			Tin		
	Storage in weeks	6	12	18	6	12	18	6	12	18
		Reflectance values								
1. Flour— 6.7% initial moisture		56.0	56.0	55.5	56.5	55.5	57.0	57.0	55.0	54.5
2. —do— + fumigation		53.5	53.0	53.5	53.5	54.5	54.0	53.0	55.0	54.0
3. Flour + antioxidant		54.5	55.0	54.0	56.0	56.5	56.0	55.0	55.5	55.0
4. Flour + fumigation +antioxidant		52.0	54.0	54.0	52.0	53.0	54.5	52.5	52.0	52.5
5. Flour— 9% initial moisture		53.0	53.0	52.0	53.0	53.5	—	54.5	53.0	53.5
6. Flour—11% initial moisture		—	—	—	—	—	—	51.5	50.0	49.0
1. Grits— 6.7% initial moisture		42.5	43.0	44.0	43.0	44.5	45.0	47.5	45.5	46.0
2. —do— + fumigation		42.0	42.5	43.0	45.0	44.0	41.5	45.0	42.5	43.0

* Similar data were obtained with samples stored at 80°F and 60-70% R. H.
Initial colour of the flour and grits was rated as 54 and 43 respectively.

TABLE V. *Free fatty acid content* of peanut flour, grits and cake stored at 100° F and 90% R. H.*

Treatments	Package	Polyethylene loose liner			Polyethylene laminated bag			Tin		
	Storage in weeks	6	12	18	6	12	18	6	12	18
1. Flour—6.7% initial moisture		7.6	10.4	15.2	6.7	11.0	14.9	6.7	9.5	13.2
2. —do— + fumigation		7.2	11.2	17.0	6.8	10.0	18.9	6.9	12.3	17.2
3. Flour + antioxidant		9.0	14.7	19.5	7.7	11.5	18.1	7.1	11.4	14.2
4. Flour + fumigation +antioxidant		6.6	12.5	20.3	6.5	10.4	14.6	7.0	9.2	12.4
5. Flour— 9% initial moisture		9.9	14.2	20.0	9.9	13.3	—	9.6	13.9	18.2
6. Flour— 11% initial moisture		—	—	—	—	—	—	11.0	16.0	20.5
1. Grits—6.7% initial moisture		5.2	7.3	12.8	4.7	7.8	11.5	4.9	7.2	10.1
2. —do— + fumigation		6.0	8.7	11.5	6.8	8.2	12.4	5.5	8.0	11.4
1. Cake—6.7% initial moisture		5.0	7.5	12.3	5.5	7.2	12.3	6.2	7.7	11.3
2. —do— + fumigation		6.8	7.6	10.8	6.0	7.0	10.7	5.5	7.6	10.6

* Expressed as per cent oleic acid on the basis of oil content. Initial free fatty acid content of the material ranged from 3-4%.

All the samples tested had a residual lipase activity which remained constant during the storage period (1.25—1.50 ml. of 0.1 N NaOH/g). This indicates the necessity for further studies to see if certain conditions of pre-cooking and pressing could inactivate the enzyme without qualitative injury to the protein.

The stored samples gave a positive Kreis test at the end of 6 weeks. However, the Kreis values could not be correlated with organoleptic scores. It is interesting to recall here that like wise Rockland *et al*[8] observed no correlation between organoleptic score and peroxide value during development of oxidative rancidity in walnut kernels.

Under the conditions of the experiment, use of the antioxidant did not completely prevent the development of oxidative rancidity.

Conclusions

1. Screw press peanut cake and grits have a better shelf-life than the corresponding flour.

ABLE VI. *Free fatty acid content* of peanut flour, grits and cake stored at 80°F and 60-70% R. H. for 20 weeks*

Treatments	Polyethylene loose liner	Polyethylene laminated bag	Tin
Peanut flour-6.7% initial moisture.	8.3	8.5	9.3
—do— + fumigation.	9.4	8.5	9.7
Peanut grits-6.5% initial moisture.	6.9	6.6	7.2
—do— + fumigation.	6.5	7.2	—
Peanut cake-6.4% initial moisture.	7.5	5.7	7.9
—do— + fumigation.	7.9	7.8	7.9

* Initial FFA of materials ranged from 3-4% of oil as oleic acid).

It is desirable to store the peanut press cake as such or as grits and have it ground to the desired fineness when required.

2. Fumigation with a mixture of ethylene dibromide and methyl bromide under controlled conditions and followed by aeration leaves residues much below the permissible limits of 50 ppm. These fumigants do not affect the organoleptic quality of the material.

3. In coastal areas where the temperature may exceed 100°F and the humidity may be 80-90 per cent for a few months in the year, the flour packed in polythene laminated jute bags may be expected to keep well for about 3 months. The shelf-life will be further prolonged under moderate conditions of temperature and humidity.

4. It is important to restrict the initial moisture content of the material to about 7 per cent at the time of storage.

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PLACE OF FOOD TECHNOLOGY IN COMBATING HUNGER AND MALNUTRITION*

By V. SUBRAHMANYAN
(Central Food Technological Research Institute, Mysore)

I am deeply sensible of the honour that you have done to me by affording me an opportunity to address you on this occasion. It is a privilege to be in this great country, to meet the leaders of the profession and to benefit by their knowledge and experience. I wish, therefore, to take advantage of this occasion not only to draw brief attention to a few things that we have done, but also to refer to some others that are waiting to be done and which offer scope for development through programmes in which there is a large area for International collaboration.

I realise that it is highly inappropriate to talk about hunger and malnutrition with a well filled stomach—especially in the beautiful city of Miami, which is not only rich but also serves as a magnet for attracting more wealth, and all that goes with it, from other parts of the World. I am, nevertheless, dealing with the subject, as a picture in contrast, to draw attention to a vast field in which food technology can play a very big role, both as a means of service to a large section of humanity and also as an area for fresh enterprise and benefit to those who contribute to it.

Dr. V. Subrahmanyan delivering the *invitation address* at Miami Beach

Concept and development of food technology

More than a century ago, food technology had its modest beginning in Europe, but it owes its present stature largely to the pioneering efforts of scientists, technologists, engineers and also talented entrepreneurs in the United States of America. Added to this, research, development and sales promotion have had more generous support from the progressive leaders of the industry in this country than in any other part of the World. As contrasted with this, we have vast areas, inhabited by over two-thirds of the population of the World, which pass through gluts and famines, largely through ignorance and often times even prejudice against modern methods of food preservation and processing. Added to this, the vast majority of people have to subsist on poor and inadequate diets, while, at the same time, enormous quantities of materials rich in valuable protective constituents, are allowed to be wasted or wrongly used. The problems, as they now appear, are of a gigantic nature, but they have to be taken up as a challenge with the full confidence that there is nothing that human ingenuity, initiative and drive cannot solve. A large part of the World's sorrow and suffering and the associated socio-economic problems and political upheavals trace their origin to lack of adequate opportunities, combined with undernourishment.

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* Being an abridged version of the *invitation address* delivered at the General Session of the Institute of Foo Technologists at Miami Beach on 11th June 1962. The talk was illustrated with about 60 photographs and slides.

From the earliest days, man had shared his ood, not only with those who depend on him ut also his domestic pets and farm animals. It not uncommon to see that what forms an nimal food in one part of the World, or even one art of a country, is used as a major article of uman food in another. When the production oes down or the quality is inadequate, the animals re the first to suffer. The human being becomes nore and more dependent on what comes out f the soil, and the dietary pattern becomes both nonotonous and poor. This leads not only to oorer physical development, but also reduced nitiative and capacity for enterprise, which is the oundation for achievement.

The Central Food Technological Research nstitute at Mysore (India) was formally opened luring October 1950 by a well known national eader. When we first approached him with the equest, he had a conscientious objection to the tarting of an Institute, the work of which, in his pinion, will take away good fresh foods from the oor people, so that the industry might pack them n costly cans and bottles to sell them to the richer eople. It took a considerable amount of effort nd that too with factual data to convince him hat enormous quantities of foodgrains, as also ruits, vegetables and other categories of food re being lost every year, through spoilage of ne kind or another, and that in quite a number f cases, the loss is still of the order of at least 25—30 per cent and the function of food technology s to conserve this food and make it available to ll sections of people. The same type of view s still being held by national leaders in several ther parts of the World as well. While it is refreshing to find that this type of outlook is gradually changing, a large amount of educative work is still needed over a large part of the World. This is one of the lines in which the Institute of Food Technologists, as the World's premier body, dedicated to the advancement of the subject, can take an active lead both by itself and in collaboration with other organizations.

Infestation and pesticidal control

Bulk storage of foodgrains is possible only to a limited extent, in most countries. The major part of the produce is in the hands of farmers and merchants whose stocks, as contained in jute bags and other types of small packs, have to be stored in cheap sheds and godowns, often under conditions of high humidity and temperature. Pending any new discovery, we still have to depend on selected fumigants which involve the least amount of hazard to human life or health. Under varied climatic conditions, we got the best results through combinations of fumigants. The combination of ethylene dibromide and methyl bromide, proved a convenient mixture and the merit of the operation lies in that we can take advantage of the solubility of methyl bromide which is a gas, in ethylene dibromide, so that the mixture can be transported and utilised in the liquid phase. This has also brought down the requirement to as low a quantity as two pounds or less for every 1000 c. ft. Apart from trying new and more potent formulations, there is a great deal of further work to be done on the penetration and also the quick elimination of last traces of the fumigants. Re-infestation can be prevented by spraying the bags themselves or other covers with protective formulations in oil base and also by impregnation of jute bags. Both we and our associates have protected a few hundred thousand tonnes in this manner and have shown the possibilities in respect of a variety of commodities including grains, pulses, oilseeds, coffee, spices etc. Side by side with this, we have observed that activated kaolinic and bentonitic clays, which are absolutely safe have pronounced insecticidal action which has some relation to adsorptive properties. In this field, as also in the use of bacterial spores which we are now using on a field scale, there is scope for developing absolutely safe types of formulations.

Preservation of perishables

In the field of preservation of fruits and vegetables, our goal in most areas of the World, should be to extend storage life at ordinary temperatures through control of respiration, enzymic degradation and microbial attack, while, at the same time, retaining all the desirable features of the fresh material. In our work, we have found that the high melting component (m.p. above 75°C) of sugarcane wax is very useful as an emulsion which can also serve as a carrier for safe fungicides and also growth regulators. In the case of arecanut fruit, where the nut is used in the East for chewing, we have succeeded in preserving it in the fresh condition for more than a year by combining mild blanching with steeping for short periods in permissible mixed preservatives like sodium benzoate and potassium metabisulphite. The respiration and enzymic changes practically stop under such conditions. We have lately extended this technique to fresh peas, litchies and grapes. We believe that this is the beginning of a line of work where there is scope for collaborative study between specialists in allied disciplines.

Combating protein malnutrition

I will now pass on to a line of study which has opened out large possibilities and where International collaboration will not only lead to the development of several new industries, but also help effectively in combating malnutrition, especially in regard to proteins. This is a field of study in which the whole world is interested and in which leading workers in several countries are actively engaged. I was happy to find that Dr Jackson, the President-elect of the I.F.T., also made pointed reference to it in the course of one of his recent addresses.

In several areas of the world, the deficiency of protein in the daily diet is of the order of at least 25—30 g. per day for most age groups; calcium of the order of 200—300 mg. with added deficiencies in respect of other minerals and vitamins, and particularly A, B_1, B_2, and B_{12}. It is now generally recognised that while all age groups suffer from these deficiencies, the most drastic effects are seen in the case of pre-school-age and to a less extent in early school-age children. Considering the low economic status of a large section of people, it is futile to suggest any change of dietary pattern or to recommend that they should consume more of milk, meat, eggs or fish, all of which, are relatively costly commodities. When we started this programme of work, we were first attracted with the possibility of extending the earlier work of Dr Borsook, which is now being sponsored by the Meals for Millions Inc., a non-profit making organization, with headquarters in Los Angeles. Our first attempt was to standardise the production and to use the edible quality of meal from peanut, which is, by far the most important oilseed of India and several other tropical countries. In the formulation that we developed, we incorporated a certain percentage of chickpea meal and supplemented it with the essential minerals and some vitamins. We had enthusiastic support from the American Organization, which readily agreed to accept our product and use it for their own distribution in India. We are deeply appreciative of this gesture, and I take this opportunity to gratefully acknowledge it because it laid the foundation for our later work in this field. Today, the Indian formulation which contains about 43 per cent protein, is reaching 300,000 children in Madras State alone where it is being used as a regular supplement to the midday meals of the school children. From the summer of this year, 800,000 children in the same State, will get it besides a large number of Institutions in different parts of the country. The results obtained with the supplement at even 1/2 oz. per day, have been so impressive that the Government of India has now decided to extent the application on a Nation-wide basis.

Treatment of Kwashiorkor: The scientific data collected by us, as also by our colleagues, together with our experience of consumer response showed that there was need to improve the quality of protein, its concentration and dispersibility in water if we are to get the best results with highly malnourished children of 1—5 years. Around this time, both we and several colleagues in other parts of India had to participate in programmes relating to the treatment of *Kwashiorkor* which is pretty extensive in many parts of India. Our experience showed that while several protein-rich vegetable materials were generally useful, the quantities required for the treatment were pretty large and the children had considerable difficulty in tolerating these quantities. Skimmed milk powder was quite useful but the presence of lactose made it difficult to bring the diarrhoea under quick control. It was at this stage that we conceived of the idea of using protein isolates in the preparation of which we already had a fair amount of experience. In the earlier stages, we had considerable difficulty in persuading other colleagues to carry out similar trials. We had o go on our own, in collaboration with the local ospitals. The results that we obtained were ery striking in many respects. We found that lends of protein isolates, preferably as supplenented with small quantities of lysine, methionine nd also addition of certain essential minerals and itamins were distinctly superior to milk powder tself. Moreover, the quantity required could e so reduced that about 25—30 g. per day, istributed over 3 doses, was quite sufficient to roduce clinical cures even in pretty advanced ases in less than a fortnight. In some cases, t was possible to achieve the result even in 2-3 ays. This led us to further systematic studies nd it was found that there is a fair parallelism, f not a close one, between the protein efficiency atio of the product and the rate of improvement n the condition of the children. These findings have since been confirmed by our other colleagues in India and especially by the Nutrition Research Laboratories at Hyderabad and the Christian Mission Hospital at Vellore. We would very much like these findings to be more extensively confirmed and utilised in other parts of the World. On the basis of such findings, International Organizations like the UNICEF and also various charitable organizations can arrange for the production and distribution of concentrated products which can be easily stored and which can be used for the treatment of *Kwashiorkor* in different parts of the world.

Peanut protein isolate and its compounded blends: Side by side with the above, we worked out methods for the preparation of protein isolates, with particular reference to peanut, which is not only abundant but also offers easier scope for processing than many other protein rich materials. An interesting outcome of this work was the standardisation of a method for the direct processing of the oilseed to yield high grade oil of refined quality, together with nearly quantitative yield of protein and other components, without the use of solvents. Using such a protein, with about 95 per cent purity, we have produced several formulations, with and without addition of a certain percentage of milk powder, and with added dextri-maltose, minerals and vitamins which can be utilised in the same way as milk. A more recent development in this line has been the incorporation of the non-oil extractives of the coconut which have helped to raise the P.E.R. to almost the same level as milk protein, while at the same time, imparting a very pleasing flavour and taste.

We have worked with a number of vegetable proteins and the evidence already obtained would convincingly show that, by using suitable blends, we could not only attain the same protein value as animal proteins, but also evolve even more concentrated products, which can be used in a variety of ways. This line of approach has opened up a vast vista of possibilities which the progressive processing industries can develop and market a number of new products, with larger consumer appeal. It has practically eliminated the barrier that has so long existed between animal and vegetable proteins.

We have used the isolates and other concentrated products for the preparation of weaning foods containing 20 per cent or more of balanced proteins by using the same type of equipment as now used for Macaroni products. These have been used for child feeding programmes both by themselves and as supplements with highly beneficial results. We have also made various types of sweets, enriched breakfast cereals and preparations incorporating fruit pulp with vegetable protein. This line of work offers large scope for the future. Our colleagues in U.S.A. have done excellent work with soy protein and soy-protein isolates. We have also observed, that when supplemented with methionine, soy protein is, for practical purposes, as good as milk protein. The method of preparation of this protein should, however, be simplified so as to obtain high yields at low cost. One may also refer to the excellent work done by Dr Scrimshaw and his associates leading to the development of INCAPARINA which have given excellent results in Central America.

We are finding increasingly, from experience, that in areas like ours, even low income groups are becoming increasingly conscious of quality and that crude products, however useful, are not readily accepted. The majority of consumers, irrespective of economic status or age group, wish to have processed food preparations which are attractively packed, have good keeping quality, pleasing in taste and which require practically no cooking. If we also take into account the fact that people do not readily wish to change their dietary patterns, however deficient they may be, the practical solution will lie in the provision of concentrated supplements which even at low doses, will correct most of the deficiencies in their daily diet.

Leaf and grass proteins: The development of the foregoing lines will represent only a small part of the potentialities in this field. There are a very large number of untapped resources—such as grasses and other leafy vegetation, algae, mosses etc.,—even in the vegetable kingdom which should provide enough protein to meet the needs of all the people in the World. Many of them still present practical problems, but they are not insuperable and will one day be solved. We need more concerted effort to deal with them and to bring them to the stage of practical utilisation.

Fish flour as a source of protein enrichment: Animal foods of high quality will always be favoured over most areas of the World, when available. There are several other forms which are still not finding application. Added to this, there are the vast resources of the sea. In many countries even the seasonal catches of good fish are not being fully utilised. Production of stable and odourless fish flour should be our ultimate goal. Though the possibilities are there, we have not yet come to the stage of any large-scale application. There are several related problems starting with the preservation of the catches so as to facilitate operations throughout the year. Removal of the odour from the wet or dry material or from the solvents, the elimination of the reversion of odour are concomitant problems. There is a suggestion that the odouriferous constituents or their precursors can be found in some form so as to minimise, if not completely eliminate the smell. Our experience has shown that incorporation of calcium sucrate in ammoniacal medium prior to roller or spray drying can partly react with the flavouring constituents, as associated with vegetable proteins, casein, meat, fish etc. This indicates the possibility of a line of approach which can be extended so as to produce safe formulations that can practically eliminate the smell and make the products more versatile in their uses.

Attention to undernourishment

Surveys in different countries have shown that while a small percentage of cases of protein malnutrition come to be noticed and correctly diagnosed, the majority of cases still pass unnoticed or are not properly treated. Added to this, there are the millions of border line cases which are handicapped throughout life consequent on poor development and low resistance to disease. It may be generally expected that the types of treatment which have proved most effective in the treatment of acute conditions will also prove beneficial in the case of others. If we consider only the requirements of children at the most vulnerable stage, we will have to meet the needs of a few hundred millions—certainly more than the entire population of United States.

Conversion of low-grade foods into superior products

An important line where only some beginnings have been made would be the production of composite foods which are fairly complete by themselves and conform to the various consumer requirements. This is one of the programmes which we started in 1950 with the object of converting cassava (tapioca) flour into a material that will have the shape, properties and at the same time, higher nutritive value than rice. We had a fair measure of success on the field, but other practical difficulties come in the way. This is a field with large possibilities and offers scope for converting heavy yielding, low-grade foods into superior products.

The data collected by us from the above and related studies have shown that (1) even coarse and fibrous foods can be improved in respect of care of cooking and digestibility by physical commutation followed by mechanical reconstitution; (2) starch and certain other polysaccharides exercise a protective action on the associated oils and fats and discourage the development of oxidative rancidity. Dextri-maltose is very useful in this manner for protecting water dispersible formulations and (3) incorporation of spices not only improves the flavour and the appetising qualities but also checks the development of oxidative ancidity. Certain classes of putrefactive and pathogenic organisms are also checked by spices.

Importance and role of spices in the dietary

Closely related with the above are our findings n respect of the use of spices by themselves in arger doses. Among the spicing materials used n the East, asafoetida and garlic have pronounced antibiotic properties. In the case of garlic, we have used formulations incorporating allin (which is odourless) along with allinase to obtain a practically odourless blend, which can be taken along with, before or after food. They not only control fermentative and other putrefactive changes but also have no adverse after-effect. The antibiotic action is about a tenth of that observed in the case of tetracycline antibiotics as now marketed, but the price structure is so favourable that even poor people can afford it. We have used the preparations with fair success in the treatment of leprosy and also rheumatoid arthritis. In the latter case, the action may not be entirely due to the antibiotic properties. There is large scope for further work in this field. Some of the essential oils, especially lemon grass and palmarosa oils also possess similar properties and can also be combined with preparations such as the above.

Infant food from buffalo milk

I do not wish to say much about our work on infant foods based on milk excepting to draw attention to the fact that in a country like India, this industry could not have been possible but for the successful utilization of buffalo milk. This milk contains as much as 8 and sometimes even 10 per cent fat. The extra fat, which has to be removed, brings a good return which repays a good part of the cost of processing. The buffalo milk protein shows less stability during concentration and drying than cow's milk. This has been overcome by suitable addition of buffers such as are already present in milk.

Vegetable rennet and cheese

The successful use of the enzyme from fig latex, which, under favourable conditions, can clot several hundred of thousand times its weight of milk, has shown the way not only for the production of cheese from animal milks, but also from blends with vegetable proteins. The vegetable rennet is more versatile than animal rennet. The vegetable rennet can clot both vegetable and animal milks. This is a line, which has far-reaching possibilities for the future and has shown the way for producing new types of cheese which can be used, both as such and for enriching various types of food products.

Role of proteins in hypoglycemia

A line of work which has yielded highly promising results is the role of certain class of proteins in improving glucose tolerance. We have been using this finding in treating cases of diabetes with considerable reduction in dosage and, in some cases, even the ultimate elimination of the need for insulin. In our studies, we have been largely using calcium caseinate, which has given the best results with an intake of 30-40 g. per day. There is also considerable improvement in the general condition of the subject. The mechanism of action of the protein is still not clear as there is no close correlation between the amino acid make up and hypoglycemic action. Further work in this field with different classes of animal and vegetable proteins will lead to fruitful results.

Assistance and collaboration of International Agencies

There are a large number of other findings, many of which have also technological possibilities and which, together with the related basic researches, have been described in over 800 publications by about a hundred contributors which have appeared in various journals since about 1950. All this work was possible not only through generous provision of funds by the Council of Scientific and Industrial Research, but also through assistance in the form of equipment from various other sources, of which, special mention may be made of the assistance from the American T.C.M. and the Colombo Plan authorities. More recently, we have also received a substantial amount of assistance through the American PL-480 funds, starting with the big NIH project on protein-rich foods. International Organizations are also taking keen interest in the pursuit and extension of such work. In areas like ours, there is still a big time-lag between the development of a processing method with all the related scientific evidence and its practical application. We are trying to fabricate some of our own equipment, but assistance by way of some more modern equipment will help us to progress faster. In fields such as ours, the basic finding may be made in one country, but the application may start in another country. Such applications are eventually bound to spread to other parts of the world, with benefit to all concerned.

What is badly needed in many areas of the World is the spread of more knowledge to the common man regarding the possibilities in the field. The I.F.T. which is the premier organization, can consider how best this can be achieved. There is also need for more training programmes and I am happy to state that there is already a proposal to start a Regional Training Centre for Asia and the Far East, in the campus of our Institute, with Canadian assistance. More of such assistance will be required in the years to come, and progressive countries like the U.S.A. can play a big part in this programme.

Conclusion

Drs Babcock and Hart were pioneers in the development of food science and technology and its application, through better nutrition for the benefit of mankind. Our Institute in Mysore, with its scientific staff of over 300 in various related disciplines, is working with the same object, and our countributions would represent a small tribute to the wonderful lead given by these two great pioneers.

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Technical Seminars

THE Seminar which is a regular scientific activity of the CFTRI provides an open forum for all scientific workers of the Institute in so far as one of them presents a paper on a problem on which he is engaged or reviews an aspect of Food Science and Technology, while others participate in the discussion and express their views on the subject matter of the paper. The visits of distinguished scientists and technologists are also made use of for arranging addresses to such gatherings. Summaries of the Seminars held during February and March, 1962 are given in this section.

S (*IS*) 13

Nutritive value of balanced malt foods, by Miss Soma Korula, (*February* 21, 1962).—Introducing the subject, the speaker said that the *per capita* production of milk and other protective foods in India and several other countries in the tropical and sub-tropical regions is highly inadequate to meet the needs of the population. Consequently protein malnutrition is widely prevalent among pre-school children and there is an urgent need for developing low cost nutritious supplements using locally available protein rich foodstuffs. The speaker then briefly referred to earlier work done in India and other countries on the development of processed protein foods of vegetable origin such as malt food developed at the Institute, INCAPARINA based on sorghum, maize and cottonseed flours developed by INCAP, Guatemala. Earlier work showed that malt food based on sorghum malt, groundnut flour, Bengalgram flour and skim milk powder possessed high nutritive value and supplemented the diets of children to a marked extent. Since skim milk powder was in short supply, it was considered necessary to develop new formulations containing protein foods such as sesame flour and soya flour rich in methionine and lysine respectively in place of skim milk powder and assess their nutritive value. Four blends (A, B, C, and D) of malt foods were prepared. All contained 22 parts of ragimalt flour and 25 parts of groundnut flour. Blends A and B contained 30 parts of soya flour and C and D 30 parts of roasted Bengalgram flour. Blends A and C contained 20 parts of sesame flour while blends B and D contained 20 parts of skim milk powder.

For comparison, a milk food containing skim milk powder (70 parts), vanaspati (9 parts) and starch (18 parts) was prepared. The calcium, phosphorus and vitamins A, C and D, thiamine and riboflavin contents of the malt foods and milk food were made nearly equal by fortification with calcium salts and vitamins.

The chemical composition of the foods were determined according to A.O.A.C. methods and the essential amino acid contents, by chemical and paper chromatographic methods. The protein content of the malt foods ranged from about 29 to 38 per cent and the calcium content about 1.4 per cent. The essential amino acid composition of the malt foods was similar to that of FAO reference protein (pattern) as well as to that of INCAPARINA but the malt foods contained lesser amounts of all essential amino acids than milk proteins.

The speaker next described the results of animal experiments. The protein efficiency ratio of the proteins of different malt foods determined at 10 per cent level of protein intake over a period of 4 weeks, ranged from 2.47 to 2.67 as compared with a value of 3.54 for milk food. The average weekly growth of rats fed on diets containing 20 per cent protein from the malt foods and milk food ranged from 15.6 g to 17.1 g/week over a period of 8 weeks, there being no significant difference in the growth rate of rats on malt foods and milk food. No significant difference was observed in the haemoglobin and red blood cell count and in the protein and fat contents of livers of rats fed on diets containing malt foods or milk food.

Consumer trials showed that the products when made into a porridge 6-8 times the weight of water and sweetened with sugar were highly acceptable to a panel of tasters.

Storage studies showed that the malt foods packed in half kilo polyethylene bags and stored in sealed tin containers kept well over a period of nine months at 37°C. The losses of added vitamins A and C ranged from 20-30 per cent and 10-15 per cent respectively. The products were organoleptically acceptable after the storage period. The cost of production of the product packed in half kilo polyethylene bags and repacked in 4 gallon tins, worked out to about Rs 1.43/ kg. or about 7 nP per 50 g. which is the quantity required for supplementing the diets of weaned infants.

The speaker concluded by saying that large-scale production and distribution of balanced malt foods would help considerably in overcoming malnutrition in children of the low income groups of the population.

The points raised during the discussion were: the behaviour of the husk of ragimalt in the cooked porridge; whether the sesame meal was prepared by removing the outer skin; the initial R.B.C. and Hb content of the blood of animals; whether the malt foods could be stored without insect infestation; bacterial and mould count in the malt foods during storage; digestibility of proteins of malt food as compared to milk proteins; whether it is possible to eliminate the husk from ragimalt; whether the quality of the malt food could be improved by precooking the ingredients; cost of production, etc.

Answering the questions, Dr Swaminathan mentioned that in the preparation of ragimalt flour, a greater part of the husk is removed by sieving the flour through 80 mesh sieve, and hence husk particles are not seen separately when the malt food is cooked as a porridge. The initial values of RBC and Hb content of the blood of weanling rats from the stock colony, were fairly constant and varied only within a narrow range. The RBC and Hb contents of mature rats were somewhat higher than those of weanling rats. If precautions were taken to avoid infestation before packing, there was no infestation in the products stored in tins. As a rule the malt foods were heated at 80°C for half an hour and then packed in polyethylene bags which were in turn kept in tins. As regards the digestibility of proteins of malt foods, Dr Swaminathan said that though studies have not been done in this laboratory, the results reported by INCAP workers on INCAPARINA indicate that the digestibility of the proteins of INCAPARINA was less than that of milk proteins by 15-20 per cent. The same might apply to malt foods. A precooked roller-dried weaning food based on wheat flour, groundnut flour, Bengal gram flour and sugar has been prepared but no experiments have been done using malt flour in place of wheat flour.

The cost, *viz.*, Rs 1.43/kg. of the product includes packaging and also a small margin (10 per cent) of profit. It does not include transport and sales charges. Since the product is meant to be a supplement to the diets of the low income group of the population, the production and distribution of the product should be under government auspices on a no gain no loss basis.

The Chairman in his concluding remarks said that a product which can be made into a porridge may have restricted application and it would be desirable to develop products which can be reconstituted in water yielding a milk-like emulsion. He said that a psychological approach to the problem of extended utilization of the product should be taken into account and the product made acceptable to parents first. Packaging should be done in such a way that even a fastidious consumer would accept it willingly. He emphasized that there was a need for such a product and how far the State authorities as well as industrial interests could come into the picture was also a point worth considering.

S (*IS*) 14

Studies on dehydration of green peas, by B. S. Bhatia, (*February* 28, 1962).—Next to China, India is the second largest producer of peas in the world. Major part of the crop is used as a pulse or flour. As a vegetable, tender green peas form a delicious dish. In certain parts of the country like Uttar Pradesh, Bihar and Punjab, during the limited season lasting for a few months, the vegetable is available in plenty at reasonably low prices. With the object of making the vegetable available in all seasons in different parts of the county and ensuring competitive and economic prices to the growers, the present investigation was started.

Referring to the brine flotation method for grading the peas (for maturity) into floaters and sinkers, the speaker said that the strength of brine was so adjusted as to get roughly equal quantities of each grade for dehydration. Salt concentration required for this purpose for different varieties was 2-2.5 per cent in Bonneville and Ooty peas, 6-7 per cent in Early Badger and Baradari Special, 12 per cent in Mehdorf, 15-16 per cent in T19, Mammoth Podded Extra Early, Ford Hook Wonder and Dwarf and 18 per cent in Bangalore peas. With the increase in maturity, moisture and ascorbic acid content decrease and alcohol insoluble solids (AIS) increase. Cooking time decreases with maturity within the range of maturities corresponding to 9-19 AIS (85-95 Tenderometer reading). This range is the optimum for the quality of dehydrated product, but because of yield considerations later maturity (19 AIS or 95 Tenderometer reading) should be preferred.

For the retention of chlorophyll and green colour in the dehydrated product, a pH of about 7 in the blanch liquor was considered to be optimum. This could be obtained by steeping peas in 2 per cent sodium carbonate solution for 30 minutes (which also helped in reducing the cooking time), washing in water and blanching in boiling solution of 0.1 per cent sodium bicarbonate. Addition of 0.1 per cent magnesium oxide resulted in a bright green coloured product while for adequate storage life, addition of 0.4 per cent potassium metabisulphite was essential which resulted in about 400 parts per million of sulphur dioxide in the dried product.

Optimum drying conditions have been found to be: 85°C—½ hr, 80°C—½ hr, and 70°C—2 hrs. in a cross-flow drier having an air velocity of 3-4 meters per second and using a tray load of 5-6 kg/sq. m. Final drying is done at 60°C for 4 hrs. in a through flow drier having air velocity of 1 m/second using a tray load of 25-30 kg/sq. m. Vacuum drying, slitting the peas, blanching in water up to 4 minutes and increase of steam pressure from 0 to 16 p.s.i. g. in steam blanching have been reported to increase the rate of drying.

Experiments conducted to improve the rehydration capacity and texture showed that (*i*) cooking time could be reduced considerably by preliminary soaking of dehydrated peas for 2 hours or by cooking under pressure (10 p.s.i. g.), improvement made by either of these methods being practically similar (*ii*) freezing and slitting are effective in reducing the cooking time but wrinkling of seeds in the cooked peas can be controlled by slitting alone and (*iii*) use of pea hulling achine causes bruising of the seed oat and thus reduces wrinkling articularly in sinkers.

Screening of varieties for their uitability for dehydration showed hat wrinkled varieties when de-ydrated after slitting gave a pro-uct which was sweet in taste and ad acceptable flavour and texture. mooth seeded varieties were archy and weaker in flavour. hey did not require any slitting reatment. Out of the two dozen rinkled varieties examined, com-hercially available varieties like T 9, Ford Hook Wonder, Baradari pecial and Mammoth Podded xtra Early were found to be uitable. It is necessary to process eas within 6-8 hours after icking if sweetness is to be retained n the dehydrated product.

Studies on packaging and storage ndicated that (*i*) 50 per cent ERH orresponding to 6 per cent mois-ure in the dried product was the ritical moisture level above which he product deteriorated rapidly in uality, and (*ii*) for a shelf life of bout 6 months at 37°C and one year t room temperature, dehydrated roduct with about 4 per cent mois-ure should be packed in aluminium foil laminated bags or sanitary cans which offered protection against light and moisture pickup. Processing in an atmosphere of nitrogen gas was not found to be necessary.

Concluding his talk, the speaker compared canned and dehydrated peas and made reference to special advantages like natural green colour, better flavour, desirable texture, consumer's convenience to eat as and when he needs the vegetable and use of cheaper and abundantly available indigenous packaging material aluminium. Except for a slightly longer cooking time (5 minutes) in dehydrated product, advantages of dehydrated peas outweigh those of the canned vegetable.

Supplementing the talk, Dr D. S. Bhatia suggested that for commercial production of dehydrated peas, it might be desirable to have well organised large farms.

The points raised during the discussion were: (*i*) whether smooth seeded variety of lower maturity could be used instead of wrinkled variety, (*ii*) various factors affecting efficient freezing as a pretreatment, (*iii*) drying ratios in different varieties, (*iv*) preservation of peas by steeping technique, (*v*) changes in chlorophyll during different stages of dehydration, (*vi*) nature of alcohol insoluble solids, (*vii*) utilisation of peas not suited for dehydration, (*viii*) an integrated approach in making use of canning, freezing and dehydration as methods of preservation, (*ix*) differences in the chemical composition of smooth and wrinkled varieties, (*x*) effect of harvesting peas at immature stage on the yield, (*xi*) effect of magnesium oxide on the cooking quality, (*xii*) basic disadvantages in using very tender peas, (*xiii*) any method of arresting biological changes at the pod stage etc.

In the course of his reply, the speaker emphasized that for efficient preservation with preservatives, low pH was desirable, while chlorophyll was stable around neutral pH. It was not considered feasible therefore, to make use of steeping procedure without adding artificial colour.

Smooth seeded variety of lower maturity could not be used in place of wrinkled variety due to its weaker flavour and hard texture. Drying ratios in different varieties were being determined. He agreed that integrated approach was desirable to utilise peas of different grades for canning, dehydration, freezing and compounded soup powders. Harvesting of peas at immature stage reduced the yield. Magnesium oxide in the concentration used had no effect on the cooking quality of peas. No satisfactory method was at present available to arrest the biological changes at the pod stage.

Concluding, the President said, that steeping technique was yet to be proved on a large scale. He emphasized that the research workers should aim at producing a quality product which would be as near to fresh material as possible and remarked that, as consumers are the best judges, the processed product should meet their requirement.

S (*IS*) 15

Some studies on the preparation of oleoresin of *Capsicum* (red chillies), by G. L. Tandon (*March* 9, 1962).—Chillies are grown in very large quantities in India. Available figures indicate that Andhra Pradesh produced 95,000 tons in the year 1960 and Mysore State produced 24,745 tons of red chillies during the year 1959-60.

After reviewing the literature, the speaker stated that the work on the assessment of the quality of chillies was undertaken because of the need for the oleoresin of *Capsicum*. At present, chillies are exported to Ceylon, Oman, Saudi Arabia and Czechoslovakia and possibilities of export to U.S.A., and other hard currency areas need to be explored. The speaker stressed the importance of utilisation of by-products, such as bland oil and colouring matter obtained during the production of oleoresin.

He then presented data showing variation on the chemical composition of chillies with regard to moisture, ash, volatile and non-volatile ether extracts, protein, crude fibre, etc.

Based on chemical composition, Indian chillies as available in the local market, compare favourably with the chemical standards laid down for chillies by U.S.A. and Canada. However, they differ greatly in their physical composition when compared to Paprika of Hungary and Pimiento of Spain.

Indian chillies contain about 40 per cent pericarp, 54 per cent seeds, and 6 per cent stems, whereas Paprika and Pimiento contain 62 and 56 per cent pericarp, 31 and 36 per cent seeds, and 7 and 9 per cent stems respectively. The ascorbic acid content of whole chillies was found to be about 29 mg. per cent while pericarp, seeds and stems contained 38.6, 15 and 9 mg. of ascorbic acid respectively.

The capsaicin content of whole chillies was 177 mg. per cent while pericarp and seeds contained 39.4 and 35 mg. per cent of capsaicin respectively. Thus about 90 per cent of capsaicin is present in the pericarp and 10 per cent in the seeds, while stems contain only negligible quantity.

The absorption spectrum of capsaicin dissolved in petroleum ether showed a peak at 284 mμ and this absorption characteristic serves to detect the presence of other pungent principles added as adulterants to powdered chillies. Whole chillies contain 173.3 mg. per cent, pericarp, 367.7 mg. per cent, seeds 1.79 mg. per cent and stems 20.88 mg. per cent of the total colouring matter expressed as β-carotene; while the content of β-carotene itself was to the extent of 12.5 mg. in whole chillies, 26.14 mg. in pericarp, 0.33 mg. in seeds and 1.66 mg. in stems on per cent basis.

By percolation method of extraction, it was observed that ether extracts 66.48 per cent, acetone 67.69 per cent, hexane 58.12 per cent, chloroform 61.12 per cent, and alcohol 19.71 per cent of the total colouring matter. When oleoresin of capsicum was made from ether extract, 66.54 per cent of colouring matter was carried in the bland oil which had separated on treatment with alcohol. The maximum absorbence of the oleoresin was found to be at 450 mμ and 452 mμ and this helps detection of any added colouring matter.

In the preparation of oleoresin of capsicum, the particle size of chillies determine the extraction capacity, the yield being higher with increasing fineness of the material. It was observed that alcohol was the best solvent in continuous extraction and ether in the percolation method of extraction.

The speaker then referred to three types of losses of solvent, viz., absorption of solvent by cake, evaporation of solvent during percolation and evaporation during distillation. When extraction was made in open containers, the loss may be as high as 32.5 per cent depending upon the kind of solvent used. In order to minimise the solvent losses, it is essential that extraction should be done in closed containers and to recover the solvent later by distillation under vacuum.

Physical and chemical characteristics of capsicum extract prepared by percolation method using ether, alcohol, acetone, hexane and chloroform as solvents showed that viscosity of the oleoresin depended upon the solvent used. The oleoresin contained as high as 515-701 mg. per cent capsaicin. The oleoresin extracts obtained by different solvents were stored at 55°C and the peroxide values showed that oleoresin was more stable when dissolved in ether among the solvents tried.

The speaker then described the methods of extraction of bland oil and enumerated its physical and chemical constants. Its acid and iodine values were found higher than those of groundnut and mustard oil. Bland oil contained most of the colour which reduced on storage, the loss being higher at higher temperatures.

The speaker observed that the industry is using whole chillies for the manufacture of oleoresin of capsicum. The bland oil, which is highly coloured, is at present wasted. Further, separation of bland oil from oleoresin is an elaborate process. Most of the colouring matter is carried into the bland oil, leaving only small quantities in the oleoresin and thus reducing its value. He stressed that pericarp is the only suitable raw material for the manufacture of oleoresin of capsicum, as seeds contain very little of it. It is, therefore, essential that seeds should be separated from the pericarp for the preparation of oleoresin. The separated seeds may be used for the extraction of oil which is colourless and can be used for edible purposes or for making soap.

In conclusion, the speaker mentioned that future programme of work would include the study of (*i*) Variation of capsaicin content during growth of fruit in different varieties produced in different regions (*ii*) Loss of carotene and colouring matter during sun-drying and dehydration and further storage of chillies (*iii*) Utilization of bland oil (*iv*) Separation of colouring matter from bland oil, and (*v*) Finding out the variation in capsaicin content during storage of chillies and oleoresin under different conditions.

During the discussion, the points raised were:. Collection of data regarding the import of oleoresin of capsicum by other countries; Cultivation of chillies containing less seeds; The price of β-carotene obtained as a by-product in the manufacture of oleoresin and how it compares with the price of synthetic β-carotene; The effect of capsaicin (oleoresin of capsicum) on insects; Methods to remove traces of solvent and to avoid crystallization of the material; Exploring possibility of utilizing protein in chillies and pressed cake; The nature of flavour in green chillies and the effect, if any, on drying.

Winding up the discussion, the President pointed out that the work should be extended to other varieties of chillies as available in different parts of the country. He stressed that the work should be done on a large scale and the nature of flavouring material present in green and dry chillies should be investigated.

S (*IS*) 16

Studies on pectolytic enzyme production by fungi, by T. N. Ramachandra Rao and K. R. Srikantiah (*March* 17, 1962).—Speaking first, Dr T. N. Ramachandra Rao briefly outlined the work in progress on enzymes relating to amylase, pectinase, cellulase and amyloglucosidase. He then referred to the genesis of the probm of pectic enzymes in relation to he needs of the fruit juice industry n India, whose current needs for hese enzymes are being met by mports.

Referring to different sources, he speaker said, that these enzymes were absent in man and other ertebrates. Their presence in the igestive juices of snails and Aphids ad been indicated. Among the igher plants, the speaker said, that ucumbers, avocados, pears, tomaoes, citrus fruits and leaves of *moringa* showed the presence of ectinesterases, which worked mainly in the alkaline pH. The most otential sources were the microbes nd these were dealt systematically n the order, bacteria, yeasts, treptomycetes and fungi. Both naerobic and aerobic bacteria, nainly used in retting, produced ectinesterases and their activity was n the range of pH 6.5—9.0. In he case of yeasts, polygalacturonase with an optimum pH of 4.5 has been investigated extensively and hown to be an unienzyme system. More recently, the streptomycetes were being investigated, but their nutritional requirements limit their use.

He then referred to the work on pectic enzymes carried out in India from 1930 to 1962. The earlier work related to plant pathogens, and later workers like Pavgi and Sreenivasan have worked on polygalacturonase from moulds. More recently, Bhat and his co-workers have worked on yeasts and streptomycetes. He concluded by saying that the project had a limited objective of preparing pectic enzymes from moulds, as they work in acid pH (3.5—5.5) and were, therefore, preferred for use in fruit juice clarification and extraction.

The subject was then taken up by Sri K. R. Srikantiah, who briefly explained the use of mould-polygalacturonase in various fruit juice industries and presented data relating to screening and laboratory trials carried out on selected moulds. 27 mould isolates were screened and depending upon the activity, as determined by viscometric method, *Aspergillus aureus* and *Penicillium expansum* were selected for detailed studies. Referring to use of carbon sources, the speaker said, that glucose was suitable for *Aspergillus aureus* while *Penicillium expansum* preferred sucrose. In the case of nitrogen sources, ammonium-nitrate and asparagine were both utilized equally well. Studies on surface and sub-merged cultivation revealed that, *Aspergillus aureus* could be used for both the types while *Penicillium expansum* was better for submerged process only.

Two types of preparations, namely 'mouldy bran' and 'precipitated crude enzyme powder' were prepared by growing *Aspergillus aureus* on wheat and defatted rice bran. These two preparations were used for clarification of grape juice and for extraction of juice from fleshy fruits like banana and guava. The results reveal that good clarification as well as 5 to 7 per cent increase in juice yield is obtained in the case of grapes. As regards banana and guava, on the basis of the pulp used, a juice extraction of 60 to 70 per cent is obtained. Moreover, the vitamin C values of guava have been retained in the treated juice during a period of 4 months storage. Large-scale trials with various fruits were carried out and samples have been sent to the industry for their opinion. The speaker briefly outlined the future programme of work relating to storage studies at different temperatures, some preliminary work on the nature of the enzymes, large-scale trials, etc.

The points raised related to, the presence of methyl alcohol, obtaining clear juice from tamarind, other associated enzymes in mouldy bran, nature of Endo PMG, Endo PG and Exo PG in surface and submerged mould fermentations, optimum pH and temperature, the age of foreign samples, use of mutants, effect of storage on activity, proper use of pulp residue, development of smell when yeast PG was used, pH variation and carbon source, retention of carotene in mango juice, the speed of the shaker and increase in activity, correlation in activity between surface and sub-merged process at the end of 4 days, desirability of diluting the banana juice and carbonating it, lack of flavour in some batches particularly grapes, pectic acid as substrate and method of peeling the orange segments by enzyme.

The speakers replied by stating that so far no attempt had been made to purify and study the nature of the enzymes in the mouldy bran prepared by them. Regarding surface and submerged processes, a great deal of work remains to be done and conditions standardised. Though a large number of methods are available for estimating the enzyme activity, viscometric method as recommended by Bell, has its advantages in testing a large number of samples. There is a need for proper study of the utilization of the pulp residue and for storage studies of the mouldy bran. The speakers added that other suggestions offered by members would be utilized in planning the future programme of work on pectolytic enzymes.

The President in his concluding remarks said that the speakers had made a modest beginning to produce certain results in which the industry was interested. He added that the findings should be extended on a reasonably large scale to produce a product with good keeping quality and activity. Even though mouldy bran was useful and foreign companies had similar preparations for use, it was necessary to try other substrates with a view to improving the appearance and the storage life of the enzyme preparation. It was even more important to study the keeping quality of the products prepared, under high temperatures of storage over reasonably long periods. He then referred to the problem of residual pulp and said that methods for their proper utilization should be worked out. He suggested that studies on the technological aspects and chemistry of enzyme would be useful. Referring to the use of the enzyme as a substitute for lye-peeling of orange segments, he said that work should be done to standardise the conditions. He concluded by saying that some industrialists had shown interest in the process as well as the product and it was up to us to conduct large-scale trials and standardise conditions on a commercial scale.

Information and Advice

IN pursuance of the policy of rendering technical aid to food industries in the country, the CFTRI supplies information on technical and other problems, carries out analytical work and undertakes short- and long-term investigations on behalf of the industry, besides bringing out publications containing important technical advances in different aspects of Food Science and Technology. The Institute deals with a number of enquiries from various food industries and others interested in Indian processed food products. A few of the enquiries answered are reproduced in this section.

E (*P*) 24

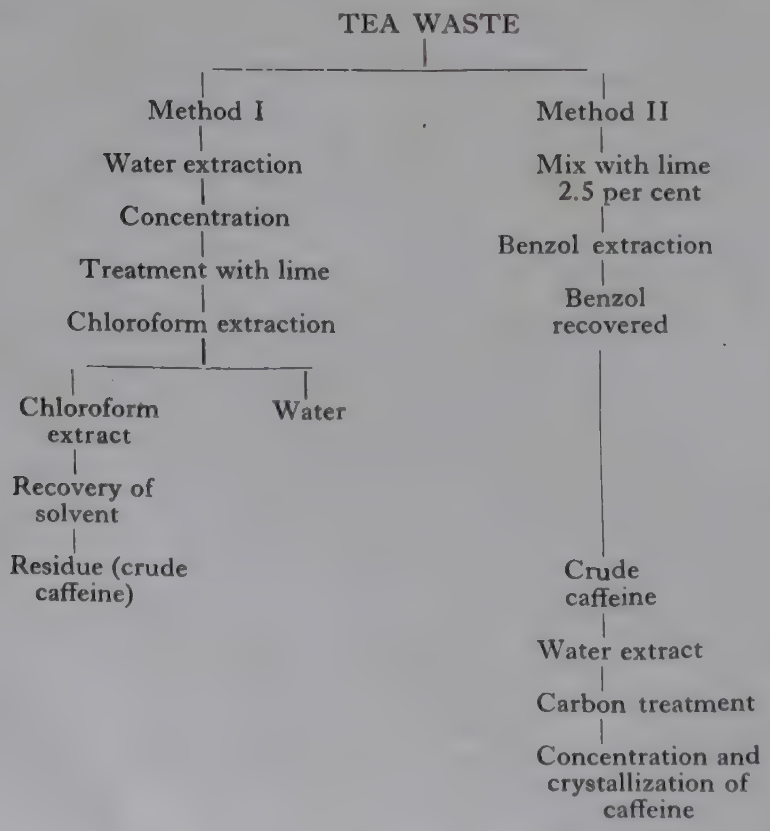
Extraction of caffeine from tea waste

Caffeine can be made from tea waste and tea prunings. The caffeine content of tea prunings will be less as compared to tea waste (Waste—1-2.5 per cent, Prunings about 1 per cent). The process of extraction from the dried material as such or in combination is nearly the same. A brief outline of the process is detailed below:

The methods available for extraction of caffeine from tea waste can be classified as follows:

1. Water extraction, mixing with lime, evaporating to dryness and extracting the powder with chloroform or other solvents. The solvents are recovered and the caffeine crystallised from water after carbon treatment.

2. Treating the waste with lime and extracting with chloroform or other solvents like hot benzol and finally recrystallising caffeine from water after carbon treatment.


TEA WASTE
Method I
Water extraction
Concentration
Treatment with lime
Chloroform extraction
Chloroform extract
Water
Recovery of solvent
Residue (crude caffeine)
Method II
Mix with lime 2.5 per cent
Benzol extraction
Benzol recovered
Crude caffeine
Water extract
Carbon treatment
Concentration and crystallization of caffeine

E (*P*) 25

Manufacturers of caffeine in India

(*i*) M/s. Bengal Chemical & Pharmaceutical Works Ltd., 164, Maniktala Main Road, Calcutta.

(*ii*) Mira Chemical Industries Ltd., Indrani Park, Tollygungi, Calcutta.

(*iii*) Calcutta Chemical Co. Ltd., 35, Panditia Road, Calcutta.

(*iv*) Standard Pharmaceutical Works Ltd., I-D., Cruze Lane, Calcutta.

(*v*) Mathur Brothers, Post Box 35, Amritsar.

(*vi*) Kerala Chemical Industries, Ettumannur (Kerala State).

E (*P*) 26

Production estimates for caffeine

The present production in India is about 12 to 15 tonnes and the target for the third plan period is 100 tonnes. The main consumers of caffeine are the pharmaceutical firms. For further details reference should be made to the Development Officer (Drugs), Development Wing, Ministry of Commerce and Industry, New Delhi.

E (*P*) 27

Manufacturers of caffeine plants

The following firms may be in a position to supply the equipment for the manufacture of caffeine:

1. Chemical Plant & Equipment Ltd., 7, Lower Chitpore Road, Calcutta.
2. A.P.V. Engineering Co., Ltd., 41, Chowringhee, Calcutta.
3. Corporated Engineers Ltd., 7, Chittaranjan Avenue, Calcutta.
4. Larsen & Toubro Ltd., Ballard Estate, Bombay-1.

E (*IS*) 28

Substitute for chicle gum

U.S.A. imports this gum chiefly from Belize in the British Honduraz. Because of the high cost of the chicle gum, many attempts have been made to find suitable substitutes but as yet no satisfactory substitute has been successfully found out to replace wholly chicle gum. However, some substitutes will compound very well with gum chicle and may be used as extenders. These are derived from the low-grade rubber of Borneo known as 'pontianak' and inferior guttas such as gutta 'siak'. Waxes, resins and balsums may also be substituted for the gum chicle. A standard formula will be as follows: chicle 14 per cent, chicle substitute 14 per cent, dextrose 14 per cent, caramel paste 1 per cent, powdered sugar 57 per cent, plus flavour as required.

E (*IS*) 29

Common sources of important essential amino acids

While sesame meal and sunflower seed meal are known to be the richest sources of methionine, sesame meal and coconut meal are the richest sources of tryptophan.

E (*IS*) 30

Sources of lower fatty acids

Depot fats of pig and ox are considered to be the richest sources of arachidonic acid. Fats of Indian marine fish such as black pomfret and pala, also contain arachidonic acid to a considerable percentage.

E (*IS*) 31

Puffed and beaten rice

Puffed rice: Many types of processed ready-to-serve foods from rice have been known in India from thousands of years. The earliest known and the most easy to prepare is puffed or popped rice. The increase in volume by puffing is considerable and the puffed rice is very porous. It becomes very soft in a few minutes when wetted. Mixed with milk, buttermilk etc., it is a ready-to-serve food and is reputed for its easy digestibility. Puffing is a very easy way of removing the husk from the paddy and it may be for this reason that it is the oldest known ready-to-serve dish common in India.

Beaten rice: Beaten rice in various forms is another popular processed food from rice. It is a type of fully parboiled rice which has been made flat and thin by pressure as to form flakes. If the pressure after the gelatinization of the rice is sufficiently intense, very thin flakes could be obtained. Roller devices that could exert a sufficiently intense pressure to flatten the rice grains would be necessary for the purpose of machanising the flaking process. In traditional flaking methods, husked rice is used and hence vitamin losses are reduced. Beaten rice would, therefore, be equivalent to parboiled rice in its vitamin value.

E (*IS*) 32

Chocolate

The recipe for chocolate is as follows:

Sugar	40	lb.
Liquid glucose	20	,,
Cocoa powder	2	,,
Butter or margarine	3	,,
Condensed milk	5	,,
Vanilla	0.5	,,
Cream of Tartar	0.125	,,
Cashewnuts (Dessert grade)	2	,,

Mix sugar and liquid glucose with a little quantity of water and start boiling the mixture for 10 minutes. Add condensed milk and butter and again allow it to boil. Then cocoa powder followed by cream of tartar is added, taking care to stir the boiling mass vigorously. When the mix has attained a thick consistency (resembles that of *Mysore Pak*), add vanilla essence and cashewnuts (fried) and again boil for 2 minutes. The chocolate mix is removed from the oven and poured on a wide plate and spread to ½″ thickness. The sheet thus obtained is cut into required sizes and allowed to cool completely. Then these pieces are wrapped first in tissue paper and then with aluminium foils and stored.

The machinery required for the large-scale manufacture of chocolate is very costly and for the details of machinery and equipment the following two firms can be contacted:

1. Messrs Kilburn and Co., Private Ltd., P.O. Box No. 1700, Madras.
2. Messrs Larsen and Toubro Ltd., P.O. Box No. 5247, 4-5, Club House Road, Madras-2.

E (*IS*) 33

Covering chocolate

Covering chocolate is broadly classified as (*i*) unsweetened covering chocolate, (*ii*) sweetened covering chocolate and (*iii*) milk covering chocolate. The Indian Standard Specification for Covering Chocolate (IS: 1163-1958) covers all these three types of chocolate and prescribes the requirements and the methods of test for determining moisture, total fat, sugar (sucrose), total ash, acid insoluble ash, crude fibre, starch and non-fat milk solids. Microscopic examination has also been included in the standard to help visual detection of adulteration. For further information, reference may be made to the Indian Standards Institution,

Manak Bhavan, Mathura Road,
New Delhi 1.

E (*IS*) 34

Chicory (*Cichorium intyleus* Linn.)

The ash of the chicory roots and also of the leaves is rich in potash. The bitter principle in chicory is probably a glucoside of fructose and pyrocatechuic acid. During storage of chicory roots, inulin is practically converted to inulide and fructose indicating the presence of an enzyme which brings about the transformation.

Chicory is devoid of caffeine and tannins. Chicory gives a characteristic colour on roasting. There is considerable distruction of inulin during roasting process and the resulting product contains increased proportions of reducing sugars together with dextrin and caramel. The chicory infusions have specific gravities varying from 1.0191 to 1.02326.

The cultivated plant is used in Indian Medicine as tonic. It is said to be useful in fevers, vomiting, diarrhoea and enlargement of the spleen. The root is a good stomachic and diuretic.

E (*IS*) 35

Daily nutrient allowances for dog

Values given are approximations for normal growth, maintenance and reproduction.

Nutrients (per kg.) body weight per day	Young Growth	Mature Maintenance
Calories	150	75
Protein	2.5 g.	3.4 g.
Carbohydrate	26 g.	17.6 g.
Fat	7 g.	1.3 g.
Vitamin A (β-Carotene)	200 I.U.	98 I.U.
Vitamin D (Calciferol)	100 I.U.	32 I.U.
Riboflavin	0.09 mg.	0.044 mg.
Thiamine	0.033 mg.	0.018 mg.
Calcium	530 mg.	260 mg.
Iron	1.3 mg.	1.3 mg.
Phosphorus	440 mg.	220 mg.

E (*IS*) 36

Amino acid composition of nigerseed kernel
(*Guizotia abyssinica*)

Protein content—28.1 per cent

Arginine	10.8
Lysine	4.1
Tyrosine	2.4
Phenylalanine	3.2
Cystine	1.4
Methionine	1.4
Threonine	2.8
Leucine	4.6
Isoleucine	1.9
Valine	2.1

Notes and News

All India Final Estimate of Rice, 1961-62

	1961-62 (Final estimate)	1960-61 (Partially revised estimate)
Area ('000 acres)	83,669	33,859
Production ('000 tons)	33,610	34,149
In metric units		
Area ('000 hectares)	82,947	33,567
Production ('000 metric tons) ...	33,658	34,197

(Economic and Statistical Adviser, Ministry of Food and Agriculture, Government of India).

Monthly (average) production of wheat flour

Year	Installed capacity	Production (thousand tons)
1959	156.6	81.3
1960	164.6	76.5
1961	164.6	91.0

Note 1. Figures represent the production of only large flour mills.

2. Number of units to which the production figures relate is 68. (*Source:* Monthly production statistics of the production of selected industries of India for December 1961, Vol. 13, No. 12, published by the Department of Statistics, Central Statistical Organisation, Government of India, Calcutta).

NEWS BRIEFS

Silica gels help stabilize beer protein: Silica gels have been found to improve beer protein stability by selective adsorption of haze-producing proteins. The product known as 'Stabifix' is such a gel. Its use in a beer of 12.6 deg. Plato original gravity, and 4.24 per cent alcohol by weight, reduced the chill-haze turbidity from 250 Radiometer units to zero.

In use, 50-100 g./hectoliter of beer (0.13-0.26 lb./U.S. *bbl.*) are added to the beer during storage or prior to filtration. The correct amount to use is best determined by a laboratory test which finds the response of the beer to different amounts of the gel. This can be done on immediate chilling of beer and after forcing tests in which higher storage temperatures are used.

The 'Stabifix' treatment hastens the stabilization that comes with ng storage of beer. Under Ger- han conditions, it could reduce torage time from 44 to 23 days nd still produce a beer completely hill-proof. (*Food Engng*, March 962, p. 119).

Consumers rate frozen French ried potatoes: When home- nakers rated four packs of frozen 'rench-fried potatoes containing arying proportions of small and dd-shaped pieces, their preferences or the different packs were in the xpected direction: As the propor- ion of uneven pieces increased, heir ratings of the product decreas- d. The number of silvers, small ieces, and irregular pieces in the acks varied from 5-50 per cent.

A sample of homemakers in ittsburgh, Pa., were asked to rate he four packs on three scales: (1) ppearance before cooking, (2) atisfaction with the product after ating, and (3) interest in selecting. f the three, the 'interest in select- ng' scale appeared to be the most fficient for demonstrating a pre- erence pattern. It showed the omemaker's degree of willingness o purchase a specific pack.

The survey indicated that, before ooking, many of the homemakers lid not detect the controlled variable r 'cue'—proportion of uneven ieces. After the potatoes were ooked, it was apparent that a large roportion of small pieces in the ack resulted in the regular pieces eing undercooked. And the criti- al cue became 'sogginess' rather han the uneven pieces, as such.

The report also provides data n the frequency of use of potatoes n general, homemakers' use of fro- zen and home made French fried, and the reasons for such use patterns (*Food Engng*. April 1962, p. 89).

Better methods, equipment for processing chickens: Evisceration is most costly operation in the many processing steps necessary to prepare whole ready-to-cook chickens. Cost of labour for this work exceeds the combined labour costs for all other plant operations. Despite this cost, there has never been an exact time value or a precise description developed for the most efficient methods of evisceration.

U.S.D.A. and the University of Georgia conducted studies to improve methods, equipment and facilities for processing ready-to-cook chickens.

Early findings show that many operations can be performed more efficiently if: (*i*) shackles on eviscerating line conveyor are adequately spaced to avoid 'search' and 'fumble' time; (*ii*) lighting is of proper intensity and comes from the right direction; (*iii*) carcasses are steadied by guide rails, keeping birds in a continuous fixed position and the 'reach' constant; (*iv*) spray rinse, properly positioned, for hands and utensils is used, instead of a solid stream of water; (*v*) work station is laid out to keep hand movements to a minimum; (*vi*) cutting motion for removing the preen gland is an upward stroke; (*vii*) layer of abdominal fat is held in place during removal of viscera; (*vii*) gizzards are not allowed to roll and tumble on peeler rolls, stripping off outside fat; (*ix*) good crew balance is maintained so that some workers are not required to work at maximum pace too long. (*Food Engng*. April 1962, p. 90).

Factors influencing foam stability in beer: Beer foam is an important factor in consumer appeal. Producing a stable foam requires: (*i*) A surface tension lower than that of water—no problem in beer. (2) A film-forming colloid to segregate out on the interfaces of bubbles. Beer is well supplied with proteins, tannins, dextrins, melanoidins and similar colloids for this purpose. (3) Satisfactory equillibrium with beer volatiles which are surface-active and tend to destroy the foam. (4) Bubbles as small in diameter as possible. (5) A non-soluble, non-diffusible gas within the bubbles.

In beer, unfortunately, the gas is carbon dioxide, both highly soluble and highly diffusible. Foam formation and bubble size have a great influence on foam stability. Small bubbles are necessary for stable foams.

In a study of 34 commercial beers there was excellent inverse correlation between bubble size and foam stability. Colloidal matter and stabilizing salts tend to produce small bubbles. Beer volatiles tend to increase bubble diameter. Volatiles play a greater role in beer foam stability than is usually recognized. (*Food Engng*., June 1962, p. 95).

Predicting quality changes in stored cottonseed oil: Some refined cottonseed oils which did not meet market specifications before storage did meet them after storage. Such changes in the characteristics of oils after storage have been related to a time-temperature factor. Given the initial characteristics of both refined and crude oils, and using the methods and formulas given in a USDA report, it is possible to predict changes in the oils during storage.

While some refined oils were upgraded during storage, crude-oil storage is not practical. Standard shortenings made from oils stored upto 4 years were judged choice in flavour and good in odor, when compared with a shortening made from fresh oil. (*Food Engng*., June 1962, p. 95).

Space spray quickly kills highly resistant insects: For quick kill of resistant insects, a new DDT formulation combines the antiresistance factor of a special agent with the rapid paralytic action of synergized pyrethrins. Called Antiresistant, the new agent restores the original effectiveness of DDT by interfering with the enzyme reaction in resistant insects which detoxifies chlorinated hydrocarbon insecticides.

The product, known as 'Pramex', has USDA label clearance for use against DDT-resistant house-flies and roaches. It also kills many other flying and crawling pests. The spary's residual effect has not yet been fully documented, but its DDT content promises excellent residual effectiveness.

The concentrated liquid contains about 28 per cent DDT, 6 per cent

Antiresistant, 0.15 per cent pyrethrins, 1.2 per cent synergist (Sulfoxide), and 64.5 per cent petroleum distillates. For spraying, it is diluted 1 part to 9 of deodorized kerosene. In tests with highly resistant houseflies, 10-min. knockdowns of 95-99.3 per cent were scored. And 24-hr. kills ranged over 99 per cent. (*Food Engng.*, June 1962, p. 122).

Instant sweet potatoes: Convenience, superior colour and taste, and absence of fibrous material are advantages cited for new instant sweet-potato flakes. They may be used in any recipe calling for sweet potatoes or yams.

Currently, the product is being nitrogen-packed in No. 10 cans ($3\frac{1}{2}$ and 4 lb. net) at 2-4 per cent moisture content. Flakes may be reconstituted in about 1 min. by wetting with hot water and stirring. They contain all the essential amino acids and are an excellent source of Vitamins A and C. (*Food Engng.*, June 1962, p. 124).

Easily dispersed pectin: High dispersion properties of a new citrus pectin are of particular interest to preservers without special pectin-dispersing equipment.

Product (Citroflash) is standardized at 150 grade. It is available in both rapid set for making jams, and slow set for jellies and confectionery use. For dispersion, 1 lb. of pectin is added to 4 gal. of 120°F. water, with agitation. No preblending with sugar is required. (*Food Engng.*, June 1962, p. 124.)

Yeast not a 'food'—No change in arsenic and lead limits recommended: A report by the Food Standards Committee reviewing the limits for lead and arsenic in yeast and yeast products recommends no change in the limits for yeast and yeast products laid down in the Arsenic in Food and Lead in Food Regulations. The committee think that yeast tablets ought not to be regarded as 'food' within the meaning of the Food and Drugs Act 1955, and of the corresponding Scottish Act, but as 'drugs'.

Publication of the report does not commit Ministers and before deciding whether or not to accept the recommendations, they will give full consideration to any representations made by the interests concerned.

Copies of the report may be obtained from Food Standards Division, Whitehall Place, London, S.W. 1. (*Food Manuf.*, March 1962, p. 126).

Electrostatic processing of meat and fish: As reported at a recent congress of the food hygiene section of the German Veterinary Society, a new and rather revolutionary method of extracting food and fodder from animal raw material has been developed by a German engineer and is in trial operation in a pilot plant in Bremen. The conventional method of obtaining protein, fats and oils from animal carcasses is by cooking followed by the extraction of superfluous moisture. But this cooking, necessary though it is, has an irreversible effect on the raw material and is associated with considerable disadvantages. In the production of fish and meat meal for example, strongly smelling waste gases are produced, and these smells must be eliminated, often by expensive means. The new method is based on the replacement of the cooking process by electrostatic impulses which are obtained from high-voltage capacitors, and applied to the material by means of carbon electrodes. The products thus obtained are claimed to be free from smell but to contain all essential factors such as fatty acids, vitamins and anti-oxidants, and have, according to tests carried out with animals, a high nutrient value and great digestibility. Encouraging tests have also been carried out with the application of electrostatic impulses to the activation or inactivation, as may be required, of microorganisms. (*Food Manuf.*, April 1962, p. 184).

Determination of moisture equilibria in dehydrated foods: A method of evaluating the relations between equilibrium relative humidity (ERH) and moisture content by vapour-pressure measurements has been used to give data on dehydrated foods. The technique is rapid and allows several determinations to be carried out on the same sample at various moisture levels. The method also has potential application as a rapid moisture-determination method giving results after observation of 1 hr. ERH is much more indicative of the behaviour of the food with respect to its moisture than is the moisture content. Data for a variety of accelerated freeze-dried foods have been obtained that are applicable to dehydration and storage problems and have indicated that the apparatus could be very suitable for further study of the behaviour of water in dried foods. (*Food Manuf.* April 1962, p. 184).

Mechanical fruit picker: Mechanical harvesting of oranges is said to be feasible with a 'mobile whirlwind' which blows the fruit off the trees.

The air blast, blowing at 12 m.p.h., is produced by a high-velocity fan mounted on a lorry which moves through the orchard at 1/4 to 1/2 a mile per hour. Vanes at the discharge end of the casing direct the air blast alternately from side to side, so clearing fruit from trees on both sides of the lorry's path.

Developers of the American machine say it removes 90 per cent of the oranges (or lemons or grape-fruit) without serious damage to trees or fruit. The whirlwind was developed after previous harvest aids, such as shaking the trees mechanically or knocking off the oranges with huge brushes, had failed. (*Food Manuf.*, April 1962, p. 188).

Water softener: It is claimed that the new Elgastat B. 113, produced by Elga Products, Ltd., now takes the complexity away from Ion Exchange techniques. At the turn of a tap the Elgastat unit produces cold purified water at tap speed. The actual flow rate is some 2 gallons per hour, and effluent cost is just a little extra than tap-water itself. A complete Elgastat B. 113, ready for use, costs £25. This price includes a conductivity meter and the world wide Elgalite Cartride Service applies. (*Food Manuf.*, June 1962, p. 295).

Powdered butter: Powdered butter has been developed by the dairy research section of the Australian Scientific and Industrial research Organisation. They state that the commercial success of butter in this form will depend on economic factors and effective promotion. It cannot be turned into normal butter merely by adding water but because it mixes easily with other ingredients it can be used in ice-cream, cake mixes, white sauce and frying batter. Although not cheaper than normal butter it contains more minerals and protein. (*Food Manuf.*, June 1962, p. 304).

Japanese fruit canning: Tangerines constitute almost two-thirds of the Japanese fruit-canning industry, and the bulk of its export trade. The current pack, in metric tons:

	Production	*Export*
Tangerines	95,504	46,736
Peaches	27,064	3,048
Pears	4,064	1,016
Cherries	2,032	...
Medlar	3,048	...
Apples	4,064	1,016
Other	6,096	5,080
Total	141,872	56,896

(*Food Technol.*, March 1962, p. 77).

Standard for fish flour: The Food and Drug Administration has approved a standard of identity for fish flour following study of a proposal to market in the U.S. a 'whole fish flour' made by grinding and drying entire fish of various sizes and varieties.

FDA had previously expressed the opinion that the original proposal would result in a product that would be classified as filthy, and thus illegal under the Federal Food, Drug, and Cosmetic Act.

As a result of the study, FDA has published an order establishing a standard for the marketing of 'fish flour' in the U.S. The flour must be made from cleaned fish after discarding the heads, tails, fins, viscera, and intestinal contents. A product meeting this standard would be legal for shipment within the U.S.

The text of the order was published in the Federal Register of January 25, 1962.

Under the present Act, it is entirely legal to prepare in the U.S., for export only, a 'wholefish flour' by grinding and drying the entire fish. This may be exported to any country whose laws do not prohibit such a product. (*Food Technol.*, April 1962, p. 53).

Two new General Foods products: Two new products have been introduced by the Atlantic Gelatin operation of General Foods Corporation.

Citroflash, a citrus pectin with high dispersion characteristics for preserving jams and jellies, is standardised at 150 grade and available in both rapid set, for making jams, and slow set, for jellies and confectionery use. Although it is designed primarily for preservers that do not maintain special equipment for dispersing pectin, Citroflash offers the same qualities as regular Atlantic Citrus Pectin.

For dispersion, the manufacturer recommends that one pound of Citroflash be added to four gallons of water, with agitation, at approximately 120 degrees F. No preblending with sugar is required.

Atlantic BJB-91, an improved gelling agent for processing bakery jellies formulated with a variety of food ingredients in a carefully balanced proportion, is designed specifically to produce a bakery jelly for doughnuts, biscuits, jelly rolls, Danish rolls, sweet dough, and other baked goods. Atlantic BJB-91 permits the jelly to pump and spread easily as well as resist oven heat and help overcome 'weeping'.

For a pumpable bakery jelly, the manufacturer recommends the addition of seven or eight ounces of Atlantic BJB-91 to each 40-pound pail of jelly. The full range is seven to ten ounces per pail, but the higher Atlantic BJB-91 level results in a less-pumpable jelly, although the jelly will become more firm and oven-resistant at the higher level. Atlantic BJB-91 also eliminates the necessity for whipping or pre-working the jelly prior to pumping. The new product can be used in jellies made synthetically or with fruit juices. (*Food Technol.*, May 1962, p. 123).

Seaweed converted to Agar Agar: The recently completed Hachiochi plant, near Tokyo, of the Japan Seaweed Industry Company is now in full production converting seaweed to agar agar for the food industry at a dollar volume of 5 millions a year. The company is a subsidiary of Eisenberg and Co., Inc.

The plant uses the well-established chemical method in which the raw material is broken down by alkali treatment, in addition to a continuous process, perfected by its own engineers, that involves digestion at high pressure, and subsequent freezing to separate unwanted constituents.

The first step in agar agar production by the 'conveyor belt' system is to mix the seaweed with water by mechanical agitation, and to subject the slurry to high pressure in an autoclave. Next comes filtration by centrifuging, but on extraction the filtrate still contains various undesired proteins and impurities. These are removed by freezing the material. Then, on melting the ice, the purified agar agar is deposited in the conveyor while the impurities drain away.

Finally, the product is bleached, dried, and crushed to reduce it to the powder form in which it is marketed. (*Food Technol.*, June 1962, p. 95).

Automatic smoker: A new automatic fish smoking machine has been invented by Dr D. L. Nicol of the D.S.I.R. Humber Laboratory (Hull), and is being offered by the National Research Development Corporation for manufacture under licence. In traditional curing methods, smoke is produced by the partial burning of saw-dust and wood shavings on the floor of a kiln. Food products cured by this method, however, differ considerably in appearance and flavour, because the operation of the kiln depends on weather conditions, which affect the air flow pattern, and on the skill with which ventilation and combustion controls are operated.

The new Humber generator overcomes these difficulties, is entirely automatic except in filling the supply hopper with sawdust, and uses only about a quarter of the sawdust required for the old method. (*Food Technol. Australia*, March 1962, p. 113).

Salmonellae in desiccated coconut: A bacteriological survey of desiccated coconut imported from Ceylon to the U.K. in 1959-1960 was carried out. Organisms of the Salmonella group were isolated from a variable proportion of the samples tested, and the results of the survey were published in the June Bulletin of the Public Health Laboratory Service. The finer grades, and coconut flour gave the highest proportion of contaminated samples, and in thread coconut Salmonella were isolated from only 2 of the 82 samples tested. As the counts of Salmonella per gram of desiccated coconut were so low, it was considered that danger was only likely to arise when the coconut was in contact with foods which would encourage their growth under warm, moist conditions. (*Food Technol. Australia*, March 1962, p. 123).

Freon can cause poisoning: It is well-known that the chlorinated fluorinated hydro-carbon refrigerants known under various trade names including Freon will break down in contact with hot surfaces or open flames and that the highly toxic gas *phosgene* is one of the break-down products.

A study of all gas poisoning cases from all hospitals in Sweden between 1950 and 1954 includes two cases of phosgene poisoning.

The first case concerns an agricultural worker who sprayed his bedroom with an aerosol fly spray containing freon, switched on an electric heater and went to bed. He awoke in the night with vomiting and diarrhoea and died on the following day.

In another case, a mechanic operated with an acetylene torch on a refrigerator which was discharging Freon 12 from a leak; he developed dyspnea, malaise and vomiting and required hospital treatment for five days.

Even *safe* refrigerants require care and knowledge in their use. (*Food Technol. Australia*, May 1962, p. 229).

Novel Glass containers: Among the glass exhibits at the international Packaging Exhibition held in Paris last October, were a variety of *unbreakable* glass jars, and a range of light weight bottles. The former are made by a special tempering process and are strong enough to withstand throwing a distance of 4 ft. onto a hard surface, while the light weight range are reduced in weight by up to 1/3 and are also cheaper. (*Food Technol. Australia*, June 1962, p. 282).

Double drawn aluminium cans from pre-lacquered strip: A method of pressing deep cylindrical food cans from pre-anodised and pre-lacquered aluminium strip has been developed by Alcan Industries Ltd., in its Banbury, England, laboratories, which it is claimed will reduce manufacturing costs and make aluminium more competitive with tinplate. So far in Europe only shallow cans for sardines and similar fish products have been made from such material. Hitherto, deeper cans in the U.S. have generally been lacquered, at considerably higher cost, after forming. Such spray lacquering must be preceded by thorough decreasing and expensive equipment is needed to apply and stove the lacquer, while anodising is normally a batch process involving high labour costs. (*Australian Food Manuf.*, March 1962, p. 12).

High frequency automatic travelling biscuit oven: An automatic travelling biscuit oven, which requires less than half the space of a normal oven and which reduces baking times by 50 per cent and more by means of special Redifon high frequency dielectric heating units in addition to norma radiated and convected heat, has been developed by Baker Perkins, Ltd., reports 'Food Trade Review (England).

Trials on a full range of biscuits were carried out in the Liverpoo factory of W. & R. Jacob & Co. (L'pool), Ltd., under normal production conditions. The quality of biscuits produced was fully maintained, and the application o high frequency improved the control of moisture content. This new oven will have a place in future biscuit factories, particularly wher there is a need to save floor space Production models of the oven wil be available next year.

Certain existing ovens in th Baker Perkins range can be adapte to incorporate high frequency unit to give a worthwhile increase i output, though not to the exten of the fully integrated design (*Australian Food Manuf.*, March 1962, p. 26).

Protein denaturation: Th intramolecular change causing protein denaturation is an importan factor in the deterioration of protein rich foods, particularly in relatio to the loss of solubility in dried eg and milk, and to changes in textur and water-holding capacity of mea and fish.

In order that the nature of thes changes might be understood, wor is being carried out on the effect o heat, freezing, and urea on th molecular properties of purifie proteins extracted from eggs, milk

n and meat. Changes in mole-
lar size and shape are being
asured by means of techniques
volving sedimentation in the
racentrifuge, diffusion, and vis-
sity. Other molecular changes
ve been followed with the aid of
ctrophoresis, optical rotation, and
traviolet absorption measure-
ents. (*Australian Food Manuf.*,
arch 1962, p. 48).

**New Maximent flooring com-
ound:** A new flooring compound
ıs been introduced by Burt, Boul-
n & Hayward, Ltd. (England).
he compound, named Maximent,
a liquid dressing applied to a
epared concrete base. Its value
the Food Industry stems not
ly from its resistance to chemicals
lilute sulphuric, hydrochloric and
cetic acids, and several others)
nd its hard wearing properties,
ut also from its resistance to ex-
reme temperatures of heat and
old.

Maximent is applied to the con-
rete base to a depth of 1/16 in.
nd gives a perfectly smooth finish,
ıus providing a non-dusting sur-
ace and a hygienic floor. Petrol,
il, acids and fats will not soak into
his compound and can be wiped
ff easily. The whole process of
aying the compound takes very
ittle time—in fact, something a
ittle over 24 hours after the final
pplication the floor is again ready
or normal use, and requires no
killed labour. 'Food Trade Re-
iew'. (*Australian Food Manuf.*,
962, p. 48).

A portable thermistor psychrometer that takes humidity measurements through use of wet and dry thermistor beads is available from Cole-Parmer Instrument and Equipment Co., Chicago. The instrument's response time of only a few seconds, according to the company, recommends it for accurate multiple readings in determining transient or localized conditions. Accuracy of measurements is said to be within 0.5 per cent of actual relative humidity over most of the operating range. Temperatures from 10° to 80°C. are covered by the three scales of the instrument. Because only a small amount of air is required for readings, it is appropriate for use in small closed spaces such as ovens and pipes. (*Cer. Sci. Today*, March 1962, p. 84).

Filter for calcium determinations: Coleman Instruments, Inc., is offering a new optical filter for use in calcium flame transmission measurements with the Coleman Model 21 Flame Photometer. This filter (Catalog No. 21-210) isolates the 554-mμ line of the flame colour. It was developed specifically for use with a method of calcium determination in animal feeds, the company states. The written procedure is included with the filter, or available as a Technical Report from Coleman. (*Cer. Sci. Today*, April 1962, p. 120).

Imitation peach flavour F-3521, latest addition to Givaudan's family of products, is offered by Givaudan Flavours, Inc., as a reproduction of the aroma and flavour of the natural fruit when added to the end products in which peach flavour is desired.

The announcement states that present chemical knowledge of the natural fruit is not sufficient to equip the flavorist with the proper flavomatics, isolates, or synthetics to create an imitation peach flavor faithful to its natural counterpart; he must combine his own experience with a search for new flavomatics, and then reproduce the imitation flavor with ingredients possibly different and chemically remote from those found in the natural.

Further information on this or its spray-dried version, Permaseal Imitation Peach Flavor F-3723, on request. (*Cer. Sci. Today*, 1962, p. 162).

INDIAN PATENTS

72239. *A moulding machine for the manufacture of whistling candies:* Comprising two pairs of rollers carrying moulds revolving in opposite direction, metal pins sliding in grooves on the extension of lower producing the air passage and means to produce the depression in the side of the candy and provision for inserting a stick handle before the candy leaves the moulding rollers—H. L. Hingorani and N. L. Hingorani (*Gazette of India*, Part III—Sec. 2, p. 70).

73100. *Process for the preparation of glutamic acid:* By adding a growth inhibitor to the fermentation medium after substantial growth of the micro-organism has taken place—Merck & Co., Inc. (*Gazette of India*, Part III—Sec. 2, p. 80).

75252. *Method for deodorizing oil and similar materials and apparatus for the working thereof:* Deodorizing oil by passing it through a column into which fluid flows in counter current, then treating the material that comes out with fluid to be supplied to the column—Extraction continue De Smet (*Gazette of India*, Part III—Sec. 2, p. 91).

73872. *Product for destroying pests:* Chiefly carbonic acid gas stored under pressure said gas being admixed with about 1 per cent of its weight of calcium hydroxide—J. Jean (*Gazette of India*, Part III—Sec. 2, p. 127).

72569. *Wrapping and packaging machine:* Comprising means for automatically sensing the external and internal dimensions of the article and further means for automatically wrapping and packing article with a wrapping material based on its sensed external and internal dimensions—J. K. Smith and M. W. Wilson (*Gazette of India* Part III—Sec. 2, p. 146).

74015. *Process for increasing the ratio of fructose to glucose in invert sugars and sugar solutions:* Subjecting a 10 to 15 per cent aqueous solution of an invert sugar containing a nitrogen-containing nutrient to aerobic submerged fermentation at room or slightly elevated temperature by treatment with a strain of Hectobacter Suboxydans—J. & J. Colman Limited (*Gazette of India*, Part III—Sec., 2, p. 161).

73959. *Apparatus for threshing grain:* Cylindrical surface of a rotatable drum co-operating with the adjacent surface of each of a plurality of counter-pressure members disposed around the periphery of said cylindrical surface, said counter-pressure members being spaced circumferentially of said drum and extending axially thereof, said cylindrical and adjacent surfaces being elastically yieldable relative to one another and radially of said drum—S. Stokland (*Gazette of India*, Part III—Sec. 2, p. 168).

74062. *Process for the preparation of L-lysine from diaminopimelic acid:* Reacting diaminopimelic acid with mono-decarboxylationenzymes in aqueous solution at 20 to 45°C at a pH 6.5 to 8.5, recovering L-lysine, from the mixture and racemizing the unchanged diaminopinelic acid in aqueous acid solution at 125 to 230°C and the treating racemized diaminopimetlic acid with mono-decarboxylation enzymes and recovering the additional L-lysine produced—E.I. du Pont de Nemours and Company (*Gazette of India*, Part III—Sec. 2, p. 179).

74314. *A device for making confectionary:* Characterised by that a pin secured to the disc projects within the hole so that the extruded material is tubular in section—V. L. Nagarkar (*Gazette of India*, Part III —Sec. 2, p. 195).

74463. *Oil materials for application to plants to effect artificial ripening thereof:* An oil material comprising a hydrocarbon mixture obtained as a distillation fraction in refining petroleum oil—Easo research and Engineering Company (*Gazette of India*, Part III—Sec. 2, p. 216).

81892. *Insect proofing composition:* Composition, other than one containing a mixture of amine alginate and a pyrethrin, containing a salt formed from one or more amines containing 9 to 24 carbon atoms and one or more hydrophilic, colloidal, polymeric acids and a compatible insecticide—Cooper, McDougall & Robertson Limited (*Gazette of India*, Part III, Sec. 2, p. 228).

FOREIGN PATENTS

2,992,928. *Stabilizing meat:* Stabilizing meat against bacterial and enzymatic deterioration by removing glycogen from muscle prior to slaughter, slaughtering, sealing in container and treating with ionizing radiation—R. M. Magnuson, International Minerals & Chemical Corp., Chicago (*Food Engng.*, March 1962, p. 144).

2,995,878. *Packaging:* Wrapping machine comprising conveyor with product-receiving pockets to feed products to loading station and then transferring from pockets to wrapper-feed mechanism—L. Brook, The Forgrove Machinery Co., Ltd., Leeds, Eng. (*Food Engng.*, March 1962, p. 144).

3,001,294. *Processing:* Recovering raw wheat solids from washer wastes of flour mill with solids-concentrating thickener and filter—F.R. Ofner, Industrial Processes, Inc., Portland, Ore. (*Food Engng.*, April 1962, p. 134).

3,001,727. *Processing milling flour:* Milling flour by recirculating airborne fragments of cereal endosperm in closed path, comminuting fragments while airborne and removing substantially all fine comminuted particles below predetermined size—Z. Block, DCA Food Industries Inc., N.Y.C. (*Food Engng.* April 1962, p. 134).

3,002,839. *Steeping olives:* Steeping olives in acidified brine, draining, subjecting to high pressures, removing water and oil pressed from olives that are dehydrated and sprayed with antioxidant—J. H. Levinson, Lawry's Foods, Inc., Los Angeles (*Food Engng.*, April 1962, p. 134).

3,001,561. *Peeling machine:* Comprising vessel containing rotatable bottom closure having slots and cutters and sidewall opening with rotatable disk-cutter combination—A. Van Raay, N. V. Machinefabriek 'Finis,' Ulft, Netherlands (*Food Engng.*, April 1962, p. 135).

2,995,448. *Processing.* Using a water extract of grape leaves to reduce pectinesterase activity and stabilize 'Cloud' in reconstituted citrus juices—T. J. Kew, USDA (*Food Engng.*, May 1962, p. 162).

3,004,572. *Food slicer:* Comprising conveyor assembly for conducting a product to a cutter assembly—J. R. Urschel, Urschel Laboratories, Inc. Valparaiso, Ind. (*Food Engng.*, June 1962, p. 132).

2,998,351. *Malting grain:* Continuously by water spraying, sprouting, spraying, conditioning and dry heating—W. E. Stoddart, Dominion Malting (Ontario) Ltd., Toronto, Can. (*Food Engng.*, June 1962, p. 132).

2,999,020. *Tenderizing meats:* Tenderizing antibiotic-treated meats by injecting with pepsin and trypsin—B. E. Williams, Hodges Research and Development Co., N.Y.C. (*Food Engng.*, June 1962, p. 132).

3,009,298. *Packaging:* Wrapper comprising means for entubing an article within a tube of wrapping material and means for introducing gas into tube—C. J. Gerlach, FMC Corp., Green Bay, Wis. (*Food Engng.*, June 1962, p. 132).

855,736. *Dinitrobutylphenol esters and their use in pesticidal preparations:* Compounds with excellent insecticidal, acaricidal and ovicidal activity, but characterised by negligible effects on plants and low toxicity to warm-blooded animals, comprise ester derived from 4, 6-dinitro-2-s-butylphenol and $R.CO_2H$ or $R'(CO_2H)_2$ (R is substituted for unsubstituted saturated or unsaturated aliphatic radical or is aryl; R' is alkylene or phenylene). A large range of suitable esterifying acids is given including sorbic, benzoic, acetic, phthalic acids. For use, the ester may be compounded with a solid or liquid diluent, or is preferably admixed (15) with cyclohexanone (75) and polyoxyethylated nonylphenol (to form an emulsifiable concentrate). Thus spider mite is readily controlled with 4, 6-dinitro-2-s-butylphenyl sorbate—

. R. Basford, Farbwerke Hoechst .-G. (*J. Sci. Fd. Agric.*, March 962, p. i-133).

854,442. *Hydrocarbon-substituted initrophenyl methacrylates:* Compounds useful as pesticides and ungicides (active against army worm, bean beetles, aphids, mites, nildew, e.g., *Stemphylium sarcinae-orme and Moniilnia fructicola*) comprise 2, 4- or 2, 6-dinitrophenyl nethacrylates in which the phenyl ing is further substituted in the 6- r 4-position respectively by alkyl, Ph, alkylphenyl, cycloalkyl or alky-cyclohexyl One compound specified s 2, *4-dinitro-6-capryl-phenyl methacrylate*—F. R. Basford, Rohm & Haas Co. (*J. Sci. Fd. Agric.* March 1962, p. i-133).

855,731. *Starch phosphate esters:* Starch orthophosphate esters are produced by heating a starch product containing > 20 per cent moisture in contact with an inorg. poly- or polymeta-phosphate salt at 100-175°F for a time to effect the desired degree of esterification. The heating is carried out with instantaneous removal of moisture, pH being 4—11.5. The products give colloidal solutions similar to those from potato starch and are useful for sizing paper or for thickening soups, etc. Any type of starch may be used—E. Enos Jones, Corn Products Co. (*J. Sci. Fd. Agric.*, March 1962, p. i-142).

854,703. *Removal of caffeine from coffee extracts:* Caffeine is removed from an aq. extract of coffee beans by bringing into contact at least once with an org. caffeine-solvent at high temperature (near the b.p.) in a high-duty centrifuge such that only the caffeine dissolves in the solvent (which is centrifugally separated). The solvent may be a chlorinated hydrocarbon (trichloroethylene) preferably used within 20-30° of its b.p.—F. R. Basford, Hag. A.-G. (*J. Sci. Fd. Agric.*, March 1962, p. i-146).

854,315. *Dried fat-containing milk products:* A dried, fat-containing milk product is produced by concentrating *in vacuo* (e.g., at $>$ 135° F to 40-50 per cent of solids) a fat-containing milk without altering the milk protein; homogenising the concentrate (such that no fat particle exceeds 2μ); incorporating gas (CO_2 or N_2O); then (after cooling to $>55°F$) subjecting the homogenised concentrate (containing the uniformly dispersed gas and fat particles) to drying and expansion, e.g., at $>150°F/>11$ mm., without denaturing the protein—F. R. Basford, Cow & Gate Ltd., (*J. Sci. Fd. Agric.*, March 1962, p. i-149).

856,819. *Improvement in flavour of processed food:* Details are given for the prep. from uncooked food (tomatoes, onions, watercress, etc.) of (1) a flavour precursor substrate and (2) an active enzyme prep. (stabilised by addition of an antibiotic, e.g., chlortetracycline) from the same food, combination of which will develop the characteristic flavour of the food from which (1) and (2) were made. The process is also applied to dehydrated foods (preferably steam-blanched before being dried), addition of an enzyme prep. from the same food being made to the rehydration liquid. Many examples are given. Proteolytic and lipolytic enzymes and amylases do not produce the effect —F. R. Basford, Evans Research & Development Corp. (*J. Sci. Fd. Agric.*, March 1962, p. i-152).

887,217. *Pickled onions:* A method of pickling onions consists in filling a wooden barrel with alternate layers of peeled and brined small firm onions, and brown sugar, and adding malt vinegar, previously heated with the addition of spices and allowed to cool, until the top layer of onions is covered, and the barrel set aside in a cool place for about three months by which time the onions have matured and are then transferred to jars and covered with liquid from the barrel: onions thus treated acquire an improved bitter-sweet flavour and prolonged shelf life—M. Adams (*Food Trade Rev.*, March 1962, p. 93).

887,952. *Pickling meat products:* Relates to the curing of meat products such as hams and bacon slabs, by introducing into them, pickle solution under pressure: the object is to provide a system for automatically establishing a selected final weight based on the green weight and then automatically shutting off the pickle solution when the desired percentage of pickle has been pumped into the product—Hagan Chemicals & Controls, Inc. (*Food Trade Rev.*, March 1962, p. 93).

888,581. *Bottle closing machine:* Relates to a mechanism and crimping head for applying crown corks to bottles, which avoids breaking of the bottle if the latter is not fed concentrically with respect to the crimping head—Keller & Romer G.m.b.H. (*Food Trade Rev.*, March 1962, p. 94).

886,533. *Dehydration:* A dehydration process for the production of powders or concentrates from solutions or suspensions, comprises spraying the solution downwardly in a tower, in the form of a rain of particles of diameter 5 to 2,000 microns, and providing an upwardly flowing air stream introduced at a temperature of 0° to 60°C., the conditions being adjusted so that the time during which the particles fall in contact with the air is not less than 5 secs. and the humidity of the gas passing out of contact with the particles is not less than 65 per cent—Birs Brit A.G. (*Food Trade Rev.*, March 1962, p. 94).

890,205. *Baked food products:* A dough or baking mixture for making buns, cakes, biscuits, sponges and the like, has an emulsifying agent incorporated therein, consisting of a partial fatty acid ester of sucrose in which each fatty acid radical contains not less than eight carbon atoms: the partial esters used which are soluble or dispersible either in the water present in the mixture or in fatty or oily constituents of the mixture, serve to improve the yield, texture, volume, softness, etc., of the baked products and enable the proportions of certain ingredients, such as eggs or fats, to be reduced —Howard of Illford., Ltd., (*Food Trade Rev.*, April 1962, p. 91).

889,787. *Dressing fish:* Relates to beheading cod fish to retain on the body the valuable flesh which extends into the back of the head in the form of a wedge, and to a method therefor, using a pair of cutters inclined to one another so as to leave a wedge-shaped end on the body, which includes suspending the fish freely tail downwards by the gill covers or pectoral fins, acting on the fish to tilt its head backwards and gripping and transporting the fish belly or back first past the cutters to make a wedge cut—R.G.T. Baader (*Food Trade Rev.*, April 1962, p. 91).

888,687. *Starch flour:* In a process for the preparation of a cold-swelling starch flour especially suitable for making puddings without boiling, by forming a suspension, working it up into a paste and drying it on a roller drier, the paste is fed to the drier in an aerated condition whereby any tendency for the paste to form particles having a strong external skin, at the temperature necessary for a sufficient extraction of moisture, is obviated—Dr A. O. Nahrmittel-Fabrik G.m.b.H. (*Food Trade Rev.*, April 1962, p. 91).

884,253. *Packaging:* A wrapping material having a preserving action has calcium sorbate incorporated therein either during or after its manufacture: the impregnated material is particularly useful for preserving foodstuffs—Farbwerke Hoechst A. G. (*Food Trade Rev.*, April 1962, p. 92).

891,571. *Edible dried milk:* Relates to a solid dry milk product in the form of a crisp and porous solid plate which can be packaged for sale in the form of a directly edible solid and cut or broken into pieces having the appearance of biscuits: partially evaporated milk in a syrupy condition is poured into a mould to form a uniform layer which is subjected to complete desiccation *in vacuo* at a temperature of 50°-60°C. at such a rate as to obtain a porous solid plate of greater thickness than the uniform layer of evaporated milk—Lactissa S.A. (*Food Trade Rev.*, May 1962, p. 97).

891,098. *Cheese:* Relates to a method for the preparation of cheese and cheese-like products in which cream with an increased casein content and containing lactose is acidified by lactic acid fermentation using thermobacteria, the fermentation being interrupted by cooling, and the curdled mass so formed treated to form a network of cheese particles which cannot contract and separate out whey—Propack G.m.b.H. (*Food Trade Rev.*, May 1962, p. 97).

892,244. *Resealable container:* Relates to a method of making a resealable metal container for hermetically packaging foodstuffs, in which fluid sealing composition is introduced into an annular channel on the underside of a closure, the channel having been coated with a material which forms a bond with the sealing element, impressing an end of a tubular body of open ended construction into the sealing composition in the channel and transforming the composition into a resilient mass—W. R. Grace & Co. (*Food Trade Rev.*, May 1962, p. 97).

893,422. *Smoked meat products:* Relates to smoke-house operations and deals with the problem of accurately weighing the meat products as pickled and placed in the smoke-house and determining the weight loss during the smoking process: the product being smoked is continuously weighed by a device outside the smoke-house, the weight being checked against a preset force, or signal, so that when the force corresponding to the smoked weight has decreased to the same value as a preset signal, an alarm is given by which the operator knows with certainty that the smoking has been completed and the desired weight loss achieved—Hagan Chemicals and Controls, Inc. (*Food Trade Rev.*, June 1962, p. 103).

894,001. *Milk tablets:* A milk tablet, which is rapidly and fully soluble in warm aqueous liquids such as coffee, tea and cocoa and containing the natural constituents of milk enriched with respect to one or more constituents, is composed of 10-29 per cent butter fat, 7-15 per cent milk proteins, 15-65 per cent milk carbohydrates and minor amounts of inorganic milk constituents and water—H. S. Brochner (*Food Trade Rev.*, June 1962, p. 103).

894,827. *Liquid-proof paper containers:* A process for making liquid-proof containers comprises forming, by any one of the known vacuum forming techniques, a liquid-proof liner of polystyrene, polyethylene, or pvc, and whilst the liner is warm, causing a correspondingly shaped paper or cardboard container to envelop the vacuum-formed material to which it adheres or is caused to adhere: the object is to avoid the disadvantages inherent in liquid-proof containers of the waxed coated carton type—John Waddington, Ltd. & Another (*Food Trade Rev.*, June 1962, p. 103).

893,691. *Stamping cans:* Relates to an apparatus adapted automatically to apply stamp code indicia in sequence to each of a number of cans or other articles being fed continuously past the apparatus: the stamping device is given a slight rolling effect upon contact with the article so that printing takes place progressively to minimize blurring —P. F. Nichols (*Food Trade Rev.*, June 1962, p. 103).

895,259. *Filling containers:* Relates to the provision of an automatic machine for filling small bottles and jars with repetitive measured charges of liquid or semi-liquid materials, such as pastes, etc., with provision to maintain a supply of liquid to be filled, withdraw measured quantities thereof, feed the containers to a filling station in repetitive groups, deliver the material to the filling station and discharge it into the containers, the sequence of operations, including e feeding of the bottles, being tomatic and taking place at a high peed—The Multi-Fill Machine o. (*Food Trade Rev.*, June 1962, . 104).

RAFT INDIAN STANDARDS

Desiccated coconut: The raft specification prescribes the equirements in respect of moisture, at and fat acidity and also includes lauses on packing and marking and ontains three appendices for the methods of determination of mois-ure, fat and fatty acids. (*ISI Bull.*, an.-Feb., 1962, p. 51).

Wheatmeal bread: The draft pecification which prescribes the equirements and the methods of est for wheatmeal bread, does not cover white bread, fancy bread, fruit-bread rolls and chemically-aerated bread. In view of the fact that wheatmeal bread is sold at a premium in the market, there is a endency among the un-scrupulous manufacturers to make the bread from maida coloured with caramel so as to give it brown colour and thus get the same price as for brown bread. In order to check this undesirable practice, the draft does not allow any extraneous colouring matter in the wheatmeal bread. (*ISI Bull.* Jan.-Feb., 1962, p. 51).

Malted milk food containing cocoa: Malted milk foods containing cocoa used in this country have so far been imported. Efforts are now being made to manufacture them in this country and some manufacturing units are being set up. It was, therefore, felt that time was opportune to formulate an Indian Standard at this stage so that the new units, which have yet to start their production, could make the product in conformity to the Indian Standard. The draft specification prescribes the minimum requirements and methods of test for the material intended for use as beverage food for children, invalids, convalescents and others. (*ISI Bull.*, Jan.-Feb., 1962, p. 51).

INDIAN STANDARDS SPECIFICATIONS

Grading for vacuum pan sugar: With a view to reducing the number of grades and defining them more clearly and objectively, ISI issued **IS:498-1953** Grading for Vacuum Pan Sugar (*Tentative*) in 1953. Since no difficulty was experienced in the use of this standard, a firm standard, namely **IS:498-1961** Grading for Vacuum Pan Sugar (Plantation White) (*Revised*) has now been issued. Advantage has been taken of this opportunity to modify some clauses and also to specify metric weights and measures in the place of FPS units. The revised standard prescribes the requirements for various grades of sugar manufactured in the vacuum pan factories in India, and methods for grading such sugar on the basis of its grain size and colour. (*ISI Bull.*, March-April, 1962, p. 109).

Terminology for spices and condiments: At present a few spices are known by different names and there are also instances where the same name is given to different spices. The adoption of **IS:1877-1961** Terminology for spices and condiments is expected to clear the confusion in the trade due to inexact terminology. This standard gives a list of products which should be classed under spices and condiments, the corresponding botanical name of the plant, and their English and Hindi names. The list, which also includes the part of the plant used as spice or condiment, covers 36 botanical plants. The terms 'spices and condiments' have become so interlinked that it has been found difficult to separate one from the other. It was, therefore, felt necessary to keep these two terms together to mean the same class of products. (*ISI Bull.*, March-April, 1962, p. 109).

BHC, Technical: The Indian Standard Specification for BHC, Technical, was issued earlier as **IS:560-1955.** Subsequently, two amendments were issued regarding the determination of the moisture content and the use of either the chromatographic or the polarographic method for the determination of the gamma-isomer content instead of the combined method. Furthermore, an amendment was under preparation substituting the new chromatographic method for the determination of gamma-isomer content. In view of these, the issue of the revised version of the standard became necessary, and it has been issued as **IS:560-1961.** In the revised version, the chemical name, structural formula, the empirical formula and the molecular weight of the material have also been included besides the changes mentioned above. (*ISI Bull.*, March-April, 1962, p. 109).

DDT, Technical: With a view to incorporating the new sampling scheme, the revised method for determination of the moisture content and the metric values, **IS:563-1961** Specification for DDT, Technical (*Revised*) has been issued. This standard was first issued in 1955. The revised version also includes the chemical name, the structural formula, the empirical formula and the molecular weight of the material. (*ISI Bull.*, March-April, 1962, p. 109).

DDT Dusting powders: The revision of **IS:564-1955** Specification for DDT Dusting powders became necessary in view of (*a*) Adoption of a new sampling scheme (*b*) Incorporation of three amendments relating to the inclusion of the revised method for the determination of acidity and alkalinity, deletion of the requirement and the method of test for moisture content, and increase in the tolerance on the nominal value of DDT; (*c*) Deletion of the accelerated storage test in the test for sieving requirement.

Consequently, **IS:564-1961** Specification for DDT Dusting powder (*Revised*) has been issued. It has been prepared to facilitate the supply of DDT dusting powders of a quality most suitable for use under tropical conditions. *ISI* (*Bull.*, March-April, 1962, p. 109).

DDT Water dispersible powder concentrates: The Indian Standard Specification for DDT Water Dispersible Powder Concentrates (**IS:565-1955**) was first issued as a tentative standard for a period of two years. Experience in testing DDT water dispersible powder concentrates for suspensibility after accelerated storage indicated that the test procedure specified in **IS:565-1955** had certain limitations. The matter was referred to the Malaria Institute of India, Delhi, and on the basis of the work carried out, an amendment to this standard modifying the requirement and the test for suspensibility after accelerated storage was issued and the tentative nature of the standard withdrawn. In view of this and the three amendments issued earlier, necessity was felt to revise **IS:565-1955.** Consequently, **IS:565-1961** Specification for DDT Water Dispersible Powder Concentrates (*Revised*) has been issued. (*ISI Bull.*, March-April, 1962, p. 109).

Diazinon, Technical: A series of Indian Standards on pesticides and their formulations is being issued by ISI, and the Indian Standard Specification for Diazinon Technical (**IS:1833-1961**) is the latest addition to it. Other standards in the series cover: BHC, DDT, dieldrin, aldrin, endrin, copper oxychloride, cuprous oxide, technical and their formulations; lime sulphur solution; pyrethrum extract; nicotine sulphate solution; zinc phosphide; BHC smoke generators; malathion, technical; 2, 4-D sodium and liquid amine salts of 2, 4-D; household insecticidal spray; fumigants like ethylene dichloride, carbon tetrachloride mixture, ethylene dibromide and methyl bromide; and common names for pesticides. (*ISI Bull.*, March-April, 1962, p. 109).

Ransom M. Callicott, Vice-President of Meals for Millions, and City Councilman of Los Angeles; Dr V. Subrahmanyan, Director, C.F.T.R.I., Miss Florence Rose and Ernest R. Chamberlain, Secretary and Co-Director of Meals for Millions Foundation, Los Angeles.

Dr. V. Subrahmanyan receiving the 1962 Babcock Hart Award at the annual meeting of the I.F.T. at Miami Beach

C.F.T.R.I. NEWS

Dr V. Subrahmanyan received in person the Babcock-Hart Award for the year 1962 at the annual meeting of the Institute of Food Technologists held in Miami on 11th June 1962 for his contributions to food technology which have resulted in improved public health through some aspects of nutrition or more nutritious foods.

Dr V. Subrahmanyan undertook a world tour visiting the FAO and WHO headquarters; Tropical Products Institute, London; Southern gional Research Laboratory, New leans; National Institute of ealth, Bethesda; Massachusetts stitute of Technology, Boston; stitute of Food Technologists, ttawa; Executives of the Canadian eedom from Hunger Campaign Ottawa; Meals for Millions oundation, Los Angeles; Japanese utritionists and Food Technolo- sts at Tokyo; Dr Pascual and his oup at Manila; Australian Food echnologists and research workers Sydney and Melborne; Food echnologists at Auckland, Welling- n and Christ Church (New ealand). In addition, he had everal *discussions, press interviews, adio and television talks* at different entres in the United States, anada, Australia and New Zealand.

Dr K. J. Carpenter of the School f Agriculture, University of Cam- ridge, was the guest scientist at he Institute for a period of two nonths and was associated in tudies on coconut proteins.

OOK REVIEWS

Fruit and vegetable juice rocessing technology by Donald K. Tressler and Maynard A. Joslyn The Avi Publishing Company, Inc. Connecticut 1961, pp. 1028.

To those interested in fruit and vegetable technology, the names of Dr Tressler and Dr Joslyn are quite familiar. Their earlier 1954 publication of the Chemistry and Technology of vegetable juice production, which had already become the Bible for research and development workers in the field of fruit and vegetable juices, has now been rewritten by them including new chapters and sections on such important recent advances like microbiology of fruit juices, continuous fruit juice production, concentration by freezing, etc., along with a highly useful section dealing with analytical methods for routine and research work. In preparing this most comprehensive treatise, the authors have had the happy collaboration of twenty five experts in the field, several of them hailing from different parts of the world. The Avi Publishing Company, who have brought out this publication in their characteristic thorough and excellent manner, deserve the gratitude (praise) of many a scientist and technologist engaged in the field of chemistry and technology of fruit and vegetable juices.

The book, with its 30 chapters, is well illustrated and contains a great deal of scientific and technical data. The references at the end of each chapter are quite comprehensive and educative to the expert who would like to delve deeper into the subject. The subject index at the end of the book, covering 17 pages, highlights every conceivable subject in the field and makes it easy for the busy worker to quickly pin point in the text aspects which are of immediate importance to him. The paper, the printing and the get up of the book, with its dark blue cover, are highly pleasing. The book awaits an eager welcome by one and all engaged in the field of fruit and vegetable technology.

Of the thirty chapters packed with information, mention should be made specially of those dealing with continuous juice production, vacuum concentration of fruit and vegetable juices, concentration by freezing, dehydration of juice, volatile flavour recovery, and of chapters dealing individually with juices of fruits like apple, berries, pineapple, grape, orange, lemon, lime and tomato. The sections on quality control, analytical methods and blending techniques contain in one place a great deal of data collected from various scattered sources.

The book is on the whole a highly valuable text book as well as manual for the research worker in the field. G. S. SIDDAPPA

An anthology of food science Vol. I. (Introduction to thermal processing of foods) by S. A. Gold-Blith, M.A. Joslyn and J. T. R. Nickerson, The Avi Publishing Company Inc., Westport, Connecticut, 1961, pp. xv + 1128.

This is an unusual book in so far as anthologies are not commonly published in science, and this raises two points; firstly of principle— Do the nature of science and the quantum of literature now published permit the luxury of anthologies and secondly, the utility of this volume.

The progress of science is cumulative in such a manner that any fresh advance of science either discards the earlier data as incorrect, amends it or incorporates within itself. Every scientist, therefore, stands on the shoulders of his predecessors and is thus able to see further than those of the earlier generation. The question of what is to be discarded, amended or incorporated is decided in the context of the data available and by the scientists of the period as objectively as they can. If the scientists are objective and their selection done with proper care the question of reference back should normally not arise and consequently the need for such anthologies.

Looking back, however, at the course of the development of science and technology, we find that the scientific growth has not been lined, but a constant reference back to the originals is required and ideas that seem not promising earlier, not taken up due to social preferences or other technological reason, are picked up later with more fruitful results. This necessitates a reading in original and the appreciation of ideas of those who have made a beginning in a new direction or made profound contribution to it.

There is yet another side to the back reference. In the development of ideas of science, certain fallacies are introduced, such as Pasteur by his experiments disproved the spontaneous generation of life, though infact only a limited conclusion could be inferred from his experiments. By reading the original such fallacies could easily be corrected. Besides, with the advancement of science old ideas are amended, modified or utilised as such. Such a continuity is useful in many respects, but it can also be a source of confusion, as has been pointed out by Schrodinger, and a cause for retarding progress. Any reading of the original would therefore be of considerable benefit to the clarification of ideas.

Another point which now arises is would these be read? An eminent scientist once remarked that great scientists of the past are honoured and venerated but rarely read. And now when the contributions to science are being made at such a rapid rate and their volume is so immense, would it be possible for a scientist to go through the literature of the past, much of which has been antiquated by the recent development of ideas and technology? Would it be worthwhile to go through all that to find a single or a few worthwhile ideas, would that effort spent in research, even if it means duplication, not be economical? The answer depends upon the proper selection of the source material and its coverage. So far as this selection and coverage is concerned, the present work is worthwhile in so far as it gives not only a proper idea of the lines of developments of the thermal processing of foods, but also suggests possible lines of research. It was, however, noticed that there is a definite bias in favour of work in U.K. and U.S.A., particularly the latter. This gives an erroneous impression which is rather unfortunate. Another point which needs mention is that this topic of applied research has gained much by way of ideas and technology from the allied sciences and from the fundamental sciences, this has however, neither been brought out through the selection or made clear in an introduction. Isolation of individual topics like these, which have largely been inspired and depend upon developments in allied fields, from the main current of science and technology, without any effort at showing their interrelations, would give an incorrect idea of the development of science and technology.

Despite these two limitations, the authors and publishers need warmly be congratulated on the idea and the manner in which they have carried it out.

A. RAHAMAN

Food Abstracts

THIS section contains abstracts of papers on Food Science and Technology selected so as to serve the needs of food and allied industries in India and is divided into three parts. Part I comprises abstracts of papers published by the CFTRI, Mysore, reprints of which can be had from the Institute on request. Part II consists of abstracts of papers published in important Indian journals. Part III contains abstracts of important articles from foreign journals.

PART I (Cftri)

Active dry bakers' yeast, by Lewis, Y. S., Neelakantan, S. and Bhatia, D. S., *J. sci. industr. Res.*, 1961, **20A** (10), 591—The paper gives a review of the literature on active dry baker's yeast which has accumulated over the various scientific aspects of its manufacture in spite of the methods having been left to secret by the Industry. The aspects covered in the review embrace product materials, cultivation technique, conditions of dehydration; evaluation, reconstitution, gassing power, baking tests; quality genetic factors, substrate, fermentation, composition of the yeast, protein and glutathione contents; enzyme system; storage factors—packing, temperature and thermostability. More than forty references are cited.

—R.C.B.

Studies on the stability of allicin and alliin present in garlic, by Sreenivasamurthy, V., Sreekantiah, K. R. and Johar, D. S., *J. sci. industr. Res.*, 1961, **20C** (10), 292—The stability of allicin and alliin in aqueous extracts of garlic and in dehydrated garlic powder during storage at different temperatures has been studied. The results show that allicin in the aqueous extract of garlic loses its antibacterial activity during storage. Alliin, in aqueous extract as well as in dehydrated garlic powder, remains stable during storage over long periods.

Coenzyme Q metabolism in pantothenic acid deficiency, by Aiyar, A. S. and Sreenivasan, A., *Proc. Soc. exptl. Biol. & Med.*, 1961—Pantothenic acid deficiency results in decreases in coenzyme Q and succinoxidase activity of liver. Administration of pantothenic acid to the deficient animals results in a restoration to normal by the end of 24 hours. The deficient animals show decreased incorporation of labelled acetate and mevalonate into liver coenzyme Q, indicating a decreased synthesis of the coenzyme Q as the possible cause of lowered liver levels of coenzyme Q in pantothenic acid deficiency.

Effect of vanadium administration on coenzyme Q metabolism in rats, by Aiyar, A. S. and Sreenivasan, A., *Proc. Soc. exptl. Biol. & Med.*, 1961.—Vanadium administration results in decreases in coenzyme A, coenzyme Q and succinoxidase activity in rat livers. A marked protection against these changes is afforded by simultaneous administration of calcium pantoenate, l-cysteine hydrochloride nd disodium adenosine triphoshate. The results are discussed relation to other reported obserations on the effects of vanadium dministration.

Manufacture of cheddar heese with the milk-clotting nzyme from Ficus carica (vegeable rennet), by Krishnaswamy, M.A., Johar, D. S., Subrahmanyan, V. and Thomas, S. P., *Food Techol.*, 1961, **15** (11), 482—The maufacture of cheddar cheese with milk-clotting enzyme from *Ficus arica* (vegetable rennet) is describd. The proximate composition f such cheese compared well with hat of cheese made with animal ennet. However, the yield and rganoleptic scores were comparaively lower than animal-rennet heese. In the earlier stages of ipening, vegetable-rennet cheese leveloped a somewhat bitter flavour hat decreased during prolonged ipening.

Metabolism of vitamin B_{12} in he rat in pantothenic acid deficiency, by Aiyar, A. S. and Sreenivasan, A., *Indian J. med. Res.*, 1962, **50** (1), 89—The increased liver and serum levels of vitamin B_{12} in the deficient animals are attended by a marked increase in urinary excretion of the vitamin. A deranged binding capacity of the serum for vitamin B_{12} is indicated in the deficient animals.

Pantothenic acid deficiency results in a marked decrease in serum globulin and small reductions in albumin and 1-globulin.

The decrease in CoA and increase in vitamin B_{12} in livers of pantothenic-acid deficient animals are restored to normal within 48 hours after administration of a single dose of calcium pantothenate.

Studies on biosynthesis of coenzyme A *in vitro* by rat tissues, by Aiyar, A. S. and Sreenivasan, A., *Indian J. med. Res.*, 1962, **50** (1), 95—Significant synthesis of coenzyme A is observed in liver slices incubated with the precursors in presence of hydroxylamine hydrochloride. L-cysteine hydrochloride is the most effective sulfur amino-acid precursor followed by glutathione, l-cystine and l-methionine in that order.

Brain homogenates and erythrocytes from the deficient animals show observable synthesis of coenzyme A, when incubated with the precursors.

Some aspects of package design: Part I—hazards in handling, transportation and storage, by Raju, P. V. and Iyengar, N. V. R., *Res. & Ind.*, 1962, **7** (1), 18. —Some hazards to which packaged goods are subjected during handling, transport and storage are considered in this article. The factors are of significance in determining the material and design requirements of a package for safe transport and storage of goods.

The effect of flaking on the culinary quality of pulses, by Desikachar, H. S. R. and Subrahmanyan, V., *J. sci. industr. Res.*, 1961, **20 D** (11), 413.—The possibility of improving the culinary quality of pulses [*thur* (*Cajanus cajan*), Bengalgram, peas, field beans and soyabean] by flaking has been investigated. All the pulses (in decuticled form or *dhals*), with the exception of soyabean, when flaked to a thickness of 0.2-0.3 mm. between rollers after wetting and softening, take only 5-10 min. to cook to a soft consistency. Soyabean, however, even after flaking to 0.05 mm. thickness, requires about 10 min. for cooking. Flaking also increases the amount of water absorbed by the *dhal* during cooking.

Flaking causes the water extract obtained during cooking to be thick and viscous. This tendency, which is most pronounced in the case of *thur dhal* (*Cajanus cajan*), can be prevented by giving suitable steam treatment to the *dhal* or *dhal* flakes.

Some aspects of package design Part II—materials and design, by Raju, P. V., Rao, A. R. V. and Iyengar, N. V. R., *Res. & Ind.*, 1962, **7** (2), 43—In designing a package that is both functional and economical, a number of factors have to be taken into consideration, such as packaging characteristics of the product, the material used for packaging and cushioning, size and shape of package, and orientation of the contents. Investigations have led to certain useful findings which are presented in this article.

Studies on *Idli* fermentation: Part II—relative participation of black gram flour and rice semolina in the fermentation, by Radhakrishnamurthy, R., Desikachar, H. S. R., Srinivasan, M. and Subrahmanyan, V., *J. sci. industr. Res.*, 1961, **20 C** (12), 342.—The effect of varying the concentrations of blackgram flour and rice semolina on fermentation and *idli* quality has been studied. Assessment of individual and additive contributions of both the fermenting components has indicated that the fermentation is mediated and influenced by both blackgram flour and rice semolina. Though its auto-fermenting power is poor, rice semolina contributes microorganisms and also acts as a substrate. Blackgram flour plays a major role in the fermentation, both as a good source of microorganisms and also as a vigorous fermenting substrate. Microorganisms developed during pre-soaking of black gram flour had high auto-fermenting ability and also more potentialities to act on rice semonlia.

Effect of some volatile chemicals on the microbial spoilage of moist Kafir corn (*Andropogon sorghum*) under airtight storage, by Srinivasan, K. S. and Majumder S. K., *Cer. Chem.*, 1961, **38** (6), 529. —Kafir corn at 20 per cent moisture was fumigated with methyl bromide and ethylene dibromide and hermetically stored for 60 days at 25°—29°C. Molds and bacteria were destroyed. Changes in fat acidity, water-soluble acidity, reducing sugars, amino nitrogen, and weight/volume ratio were retarded. Similar results were obtained with chloropicrin and ethylene oxide. The possibility of cold sterilization of moist grain and storage under aseptic conditions in hermetic storage is discussed.

Intracellular distribution and biosynthesis of ubiquinone in rat liver in carbon tetrachloride liver injury, by Aiyar, A. S. and Sreenivasan, A., *Biochem. J.*, 1962, **82,** 179.—Carbon tetrachloride administration results in a decrease in the mitochondrial ubiquinone and an increase in the ubiquinone of the supernatant fraction.

Administration of vitamin B_{12} 3 hr. before carbon tetrachloride affords significant protection against this alteration in intracellular distribution of ubiquinone.

The incorporation of $^{14}C_2$ acetate and α-2-^{14}C mevalonate into ubiquinone by liver slices is decreased by carbon tetrachloride administration.

Anthocyanin pigment in passion fruit rind, by Pruthi, J. S., Susheela, R. and Lal, G., *J. Food Sci.* (*Food Res.*), 1961, **26** (4), 385. —Detailed studies were reported on isolation and identifications of the pigments naturally occurring in passion fruit rind (*Passiflora edulis* Sim.). From colour tests, distribution number, paper chromatography, sugar residue, and absorption spectra, pelargonidin 3-diglucoside reported in passion fruit rind is about 1.4 mg. of the pigment per 100 g. of the fresh material.

Content and intracellular distribution of ubiquinone in the rat in experimental thyrotoxicosis, by Aiyar, A. S. and Sreenivasan, A., *Biochem. J.*, 1962, **82,** 182.—Thyrotoxicosis results in a twofold increase in ubiquinone accompanied by an elevation of succinoxidase activity in rat liver; the rise in ubiquinone is particularly marked in the mitochondria.

Vitamin B_{12} supplementation has no marked effect on either ubiquinone concentration or succinoxidase activity, in both the control and the thyrotoxic animals.

Studies on the antihelminthic activities of seeds of *Carica papaya* Linn., by Krishnakumari, M. K. and Majumder, S. K., *Ann. Biochem. & exptl. Med.*, 1960, **20,** 551.—Experiments *in vitro* have revealed that papaya seeds contain a substance deadly to *Toxascaris transfuga*, *Accaris luombricoides* var. sins and *Pheretima sp.* while an *Ascaris sp.* from the polar bear was found to be relatively resistant. This vermicidal principle is insoluble in common organic solvents, but dissolves readily in water and in dilute alkalies. The principle is thermolabile. Papaya seed powder lost some of its vermicidal activity on storage, while in the whole seed, this activity was unaffected even after six months storage at 24-29°C. The powder kept well when stored under vacuum, nitrogen, or carbon dioxide. —K.M.D.

Composition and properties of dried peas in relation to their suitability for canning, by Lakshminarayana Setty and Siddappa, G. S., *J. Sci. Fd. Agric.*, 1961, **8,** 537.—Physical properties such as appearance, shape, water-absorption capacity and specific gravity of dried peas are related to their canning quality. *W. K. Marrowfat* and *E. W. Marrowfat*, which are typical wrinkled seeded varieties and which have a high water-absorption capacity, are good for canning. On the other hand, smooth-seeded varieties like *R. O. Dutch Blue* and *S. O. Dutch Blue* with low water-absorption capacity, and an abnormally high swelling ratio on processing, often give a mealy canned product. Others, like *Blue Dutch*, *V. S. Dutch Blue* and *U. A. Dutch Blue* exhibit hard seededness on canning.

Highly wrinkled varieties are characterised by a low starch/protein ratio, low alcohol-insoluble solids (A.I.S.) and a high sugar content, with a predominantly amylose type of starch content. Smooth-seeded varieties generally have a high starch/protein ratio, a high A.I.S. content and a comparatively low percentage of sugar. The starch in them is of both amylose and amylopectin types, the latter predominating in some of the varieties.

Wrinkled varieties differ from the smooth ones in their ash and phosphate contents and acid-base balance.

PART II (Indian)

BIOCHEMISTRY AND NUTRITION

The use of n-bromosuccinimide in the study of the composition and structure of protein by Ramachandran, L. K., *J. sci. industr. Res.*, 1962, **21 C** (5), 111.—The protocols for the use of n-bromosuccinimide (NBS) as a reagent in the determination of tryptophan content of proteins and peptides and in the selective C-tryptophyl peptide bond cleavage have been examined, and the use of this reagent in the study of the composition and structure of proteins has been indicated. The utility of this reagent in finding out whether indole residues may be a part of the 'active site' of biologically active proteins has been demonstrated. It has been shown that, with discriminating use, NBS should be of value in rapid tryptophan analyses and in the analysis of C-tryptophyl sequence differences that may exist in a particular protein derived from several species, mutants and strains of organisms.

Effect of ascorbic acid and hydrolysed glucose cycloacetoacetate on the intestinal flora and biosynthesis of thiamine in rats, by Nath, M. C. and Meghal, S. K., *J. sci. industr. Res.*, 1962, **21 C** (5), 121.—Addition of 60-80 mg. ascorbic acid per rat daily to the diets of weanling rats maintained on a thiamine-free basal diet has been found to increase urinary and faecal excretion of thiamine. Lower or higher doses of the acid are ineffective in promoting thiamine synthesis. Rats receiving 60-80 mg. hydrolysed glucose cycloacetoacetate or 80 g. ascorbic acid per day show higher *coliform* counts in the faeces than the control or other groups; the thiamine content of the tissues of the animals in these groups is much higher, indicating that the thiamine synthesized is excreted in the faeces and is made available to the animal after coprophagy.

Nutritive value of field bean (*Dolichos lab lab*): Part I—*In vitro* digestibility of raw and autoclaved beans, by Kalindi Phadke and Kamala Sohonie, *J. sci. industr. Res.*, 1962, **21 C** (6), 155. —*In vitro* digestibility experiments indicate that raw or autoclaved field beans are less digestible by pepsin and trypsin, than casein. Autoclaving the beans does not show any effect on their digestibility by pepsin. However, the digestibility of raw beans by (i) trypsin and (ii) pepsin followed by trypsin is increased by autoclaving. The increase in the digestibility is maximum when the beans are autoclaved for 5 min. at 15 lb./sq. in. pressure and is minimum when it is autoclaved for 4 hours. Microbiological estimations of amino acids indicate that field beans are deficient in almost all essential amino acids as compared to casein and methionine is the most limiting amino acid.

Physico-chemical studies on indigenous seed proteins: Part VI—amino acid composition of red gram (*Cajanus indicus*) meal and globulin fractions, by Saroj Tawde and Cama, H. R., *J. sci. industr., Res.* 1962, **21 C** (6), 162.— The amino acid composition of red gram meal as well as its three globulin fractions show the absence of histidine and low amounts of methionine and cystine. The main globulin fraction (I) contains most of the essential amino acids in good proportion except lysine, threonine and tryptophan. Lysine is present to a greater extent in fraction II, threonine in fraction III and tryptophan both in fractions II and III.

Stability of vitamin B_{12} in malt extract and honey, *Curr. Sci.*, 1962, **31** (6), 236.—The note summarises the results of investigations relating to the effects of syrupy bases like malt extract and honey on the stability of vitamin B_{12}. Malt extract, while causing about 17 per cent loss of vitamin B_{12} activity in artificial ageing at elevated temperature exerts only a mild adverse effect at room temperature. Honey is more destructive than malt extract both at high temperature and during shelf-life at room temperature. At elevated temperature 34 per cent destruction, almost double that of malt extract, is observed.

—B.V.S.

Studies on 4-dimethylaminoazobenzene-induced hepatoma in rats: Part I.—certain biochemical alterations in liver and blood, by Mitbander, V. B., Noronha, J. M., Rege, D. V. and Sreenivasan, A., *Indian J. med. Res.*, 1962, **50** (3), 478.—Liver tumours induced by feeding 4-dimethylaminoazobenzene to rats and apparently normal lobes as well as blood plasma of tumour-bearing rats have been examined. The hepatoma has low reserves of vitamin B_{12} and citrovorum factor activity, although the ability to convert folic acid into citrovorum factor *in vitro* is enhanced. There is significant rise in the DNA content of the tumour tissue; rise in RNA is small. A pronounced lowering of liver xanthine dehydrogenase and to a certain extent of the blood serum enzyme is observed. Alterations in serum protein profile include decreases in albumin and α-globulin and increases in α- and β-globulins.

Studies on 4-dimethylaminoazobenzene-induced hepatoma in rats: Part II.—alterations in certain intra-cellular components of liver, by Mitbander, V. B., Rege, D. V. and Sreenivasan, A., *Indian J. med. Res.*, 1962, **50** (3), 485.—The ability of rat-liver preparations to effect the conjugation of benzoic acid and glycine *in vitro* is enhanced significantly in hepatoma induced by feeding 4-dimethylaminoazobenzene. There is a simultaneous lowering in ATP-ase activity, particularly in mitochondria isolated from the tumour lobe as compared to the apparently normal lobe.

Mitochondria from the tumour lobe suspended in isotonic sucrose solution show low optical density and the initial as well as total release of E_{260} material from these when suspended in phosphate buffer is much lower than with normal mitochondria.

Studies on 4-dimethylaminoazobenzene-induced hepatoma in rats: Part III.—certain biochemical changes in the pre-cancerous state and the influence of dietary riboflavin and vitamin B_{12}, by Mitbander, V. B., Rege, D. V. and Sreenivasan, A., *Indian J. med. Res.*, 1962, **50** (3), 492.— Observations are reported relating to variations in total sulphydryl content, adenosine triphosphatase and xanthine dehydrogenase activities and in vitamin B_{12} of liver and in xanthine dehydrogenase and vitamin B_{12} of blood plasma in preneoplastic stages during feeding of 4-dimethylaminoazobenzene to rats.

There is a steady decline in liver SH and in vitamin B_{12} and xanthine dehydrogenase of both liver and plasma. Changes in liver ATP-ase are irregular.

The behaviour of liver mitochondria with respect to release of acid soluble nucleotides under various conditions has been studied during this period.

The effects of dietary riboflavin and vitamin B_{12} administered intraperitoneally on these alterations are reported. Whereas vitamin B_{12} apparently protects the osmotic properties of mitochondria and prevents depletion of sulphydryl, riboflavin prevents lowering of xanthine dehydrogenase in liver and plasma.

Studies on 4-dimethylaminoazobenzene-induced hepatoma in rats: Part IV—inhibition of xanthine dehydrogenase activity by a 4-dimethylaminoazobenzene derivative produced by rat liver enzymes, by Rege, D. V. and Sreenivasan, A., *Indian J. med. Res.*, 1962, **50** (3), 502.—An inhibitor of xanthine dehydrogenase is produced on incubation of 4-dimethylaminoazobenzene with rat liver homogenate aerobically. Such inhibitory activity is also formed from p-aminophenol and, to some extent, from acetanilide or aniline. Hepatoma induced by feeding the dye lacks the ability to produce the inhibitor and the inhibitor is not present in the tumour tissue. The probable relation of this inhibitor to the carcinogenic process is discussed.

Influence of B vitamins on the amino-acid interaction of tryptophan utilization by ***Neurospora crassa*****,** by Sitharama Acharya, U., Radha, K. and Shanmugasundaram, E. R. B., *Proc. Indian Acad. Sci.*, 1962, **55** (4), 183.—The sequence of the biosynthesis of nicotinic acid from tryptophan, the effect of amino-acid imbalance and some B vitamins in the conversion of tryptophan to nicotinic acid had been reviewed. Radha, Shanmugasundaram and Acharya had studied the influence of casein hydrolysate and pure amino-acids on the uptake and utilisation of tryptophan and its metabolites, by a nicotinic acid requiring mutant of *Neurospora crassa*. They found that, while casein hydrolysate and certain amino-acids inhibited the growth of the organism with tryptophan, kynurenine or 3-hydroxy-kynurenine, those compounds had no effect with the other metabolites, *viz.*, 3-hydroxy-anthranilic and nicotinic acids. Vitamins like thiamine, pyridoxine and riboflavin, biotin and PABA were known to be involved in the conversion of tryptophan to nicotinic acid. Since casein hydrolysate inhibited the conversion of tryptophan, kynurenine and 3-hydroxy-kynurenine to nicotinic acid, it was of interest to study whether this inhibition could be reversed by the vitamins known to participate in the conversion and the results are presented in this paper.

Human milk studies—chemical composition of human milk at three different stages, by Sushma Ashdhir and Puri, B., *Indian J. Pediat* 1962, **29** (171), 99.—The investigations on the chemical composition of human milk at three stages of lactation in ten women belonging to the upper, middle socio-economic group in the maternity and child welfare section of a nursing home have been carried out.

The milk was analysed for protein, lactose, calcium, vitamin A and ascorbic acid. A preliminary diet-survey of these lactating mothers was also conducted so as to assess their dietary status.

There was a slight increase in the lactose content with the progression of lactation, whereas in protein, calcium, vitamin A and ascorbic acid contents, a significant diminution was observed as the milk changed from colostrum to mature milk.

Some of the direct correlations between dietary nutrients and milk constituents have been tried and a significant correlation was found between the dietary vitamin A and milk vitamin A, the co-efficient of correlation being $r=0.74$, significant at the 95 per cent level.

DIETETICS

Iron absorption in human volunteers using high phytate cereal diet, by Apte, S. V. and Venkatachalam, P. S., *Indian J. med. Res.*, 1962, **50** (3), 516.—Twelve human metabolic studies were carried out to assess the safe level of iron intake to provide sufficient absorption of iron in four normal subjects consuming a cereal diet.

It was observed that an intake of 11.7 mg. iron per day is insufficient to meet the requirements if the cereal diet contained 40 per cent phytate.

At a level of 16.43 mg. iron intake per day, iron absorption was less than 1 per cent and the subjects were in a delicate balance with regard to their iron need.

All subjects were in a distinct positive iron balance at 21.55 mg. iron intake at which level they retained nearly 30 per cent of the intake.

The safe level of iron intake on a cereal diet with 40 per cent phytate would appear to be somewhere between 17 mg. and 21 mg. per day.

ENZYMES

Studies in the pectic enzymes of parasitic fungi: Part IV.—production of protopectinase enzyme by ***Fusarium orthoceras*** **APP. and** ***Wr. var. ciceri padwick*** **on synthetic media,** by Gupta, M. N. *Proc. Indian Acad. Sci.*, 1962, **55** (3), 120.—Production of protopectinase enzyme by *Fusarium orthoceras* var. *ciceri* was studied on various synthetic media along with various factors responsible for its production.

The fungus secreted most active enzyme on the following medium—0.5 per cent cellobiose, 1.5 per cent pectin, 0.389 per cent ammonium oxalate, 0.1 per cent $KH_2 PO_4$ and 0.05 per cent $Mg. SO_4. 7H_2O$.

Optimum incubation period for the secretion of active protopectinase enzyme was four days when cultures were incubated at 25°C.

Cellobiose was found to be the best carbohydrate for the secretion of protopectinase enzyme. Arabinose, lactose, starch and maltose were not suitable for the enzyme production.

Optimum enzyme secretion was not related with the amount of growth of the fungus.

Asparagin and ammonium salts, as compared to nitrates, were more suitable for the enzyme production.

The production of protopectinase enzyme was better in the presence of pectin.

MEAT AND FISH

Preparation of peptone and meat extract concentrate, by Mathur, I. S., Gupta, S. K. and Krishna Murti, C. R., *Res. & Ind.*, 1962, **7** (3), 96.—The article describes a simple integrated process based on digestion of meat by papain for preparing peptone and meat extract concentrate, for use as substitutes for imported peptone and beef extracts employed in the maintenance, growth and propagation of microorganisms. In general properties, chemical composition, growth-promoting efficiency and sensitivity to antibiotics, the local preparations compare very favourably with imported brands.

MILK PRODUCTS

Bacteriological quality of ice-cream sold in Delhi market, by Suryanarayana Rao, R., Natarajan, A. M. and Dudani, A. T., *Indian J. Dairy Sci.*, 1962, **15**, 39.—From the data obtained on 92 ice-cream samples collected from different manufacturers in Delhi area, it has been found that 50 per cent of the samples had a total bacterial count below 250,000 per ml., while only 20.5 per cent of the total samples had less than 10 *coliform* organisms per ml.

The wide variation observed in some samples between standard plate count and direct microscopic count would indicate that the ice-cream mix has probably been subjected to drastic heat treatment.

PESTICIDES

Organic pesticides: Part VIII.—synthesis of halo-aryl esters of phosphoric and thiophosphoric acids and certain related compounds, by Joshi, K. C. and Bahel, S. C., *J. Indian chem. Soc.*, 1962, **39** (1), 5.—Seven substituted fluorophenols have been condensed with 0:0-diethyl chlorothiophosphate to give esters of thiophosphoric acid, with phosphorus oxychloride to give phosphoric acid esters and finally with ethylene chlorohydrin to yield the corresponding ethers. All these compounds are expected to possess insecticidal activity.

PART III (Foreign)

ADDITIVES

Distilled monoglycerides for food foaming and for starch complexing, by George Y. Brokaw, *Canad. Food Industr.*, 1962, **33** (4), 36.—Monoglycerides products have been used in various foods mostly to aid in the emulsification of fat and water and in some cases to aid in the incorporation of air as the third phase in these emulsion systems. There has also been noticed its uses in starch complexing. Work in several laboratories has shown that there is a quantitative and sometimes qualitative difference in behaviour between the high purity distilled monoglycerides and the mono- and diglyceride mixtures. The paper deals primarily with the behaviour and use of the saturated distilled monoglyceride for food foaming and for starch complexing *vis-à-vis* different stages of their manufacture. The area of considerable interest is that of macaroni products and canned foods.

—R.C.B.

ANALYTICAL

A new reagent for detection of peptides, nucleotides and other N-H-containing compound on paper chromatograms, by Mazur Robert H., Ellis Bernice W. and Cammarata Peter, S., *J. biol. Chem.*, 1962, **237** (5), 1619.—With the use of *tert*-butyl hypochlorite for chlorination of susceptible N—H bonds in compounds of biochemical and organic chemical interest, two new techniques for paper chromatograms have been described. The reaction has been shown to apply to amino acids, acylamino acids, amino acid esters, peptides, proteins, purines, pyrimidines, nucleotides, amines, amino sugars, vitamins and vitamin analogues, steroid conjugates, nucleic acid, guanidino compounds and antibiotics. In all cases, 5 μg. or less of each compound could be detected after chromatography. The use of this reagent is recommended for the detection of any N—H containing compound.

Simple vacuum distillation procedure for determination of the volatile carbonyl content of autoxidising edible fats, by Lea C. H. and Swoboda, P. A. T., *J. Sci. Fd. Agric.*, 1962, **13** (3), 148.—A vacuum distillation procedure is described which, when applied to 10g. of fat, will recover quantitatively added aliphatic aldehydes ranging in volatility from propanal to dodecanal at a concentration of 0.1 h. mol/g. With autoxidising fats the method estimates, more directly than chemical tests for rancidity in present use, the class of substances responsible for rancid and reverted off-flavours.

An extraction procedure for the determination of total calcium, magnesium and potassium in plant tissue, by Thomas Greweling, *J. Agric. Fd. Chem.*, 1962, **10** (2), 138.—A method is described for the extraction and flame photometric determination of total calcium, magnesium and potassium, in plant tissue. The tissue is extracted with salts of EDTA; these salts also eliminate anion interferences in the subsequent flame photometric analysis. The results obtained by this method agree well with those obtained by flame and chemical analyses of plant ash solutions.

Polarographic determination of methyl bromide, ethylene dibromide, acrylonitrile, chloropicrin and carbon tetra-chloride in air, by Ben Berck, *J. Agric. Fd Chem.*, 1962, **10** (2), 158.—Polarographic methods were developed for rapid measurement of methyl bromide, ethylene dibromide, acrylonitrile, chloropicrin, and carbon tetrachloride in amounts as low as 10^5M with a precision within ± 5.1

per cent in air samples taken in duplicate. Methods are described for quantitative separation of binary mixtures containing carbon tetrachloride and of methyl bromide—ethylene dibromide mixtures. Sampling of fumigant gases in absorption vessels was improved by use of a 'bubble-fractionating' gas-dispersion tube.

Wheat as a chromatographic column towards methyl bromide, ethylene dibromide, acrylonitrile, chloropicrin and carbon tetrachloride in the vapour phase, by Ben Berck and John Solomon, *J. Agric. Fd. Chem.*, 1962, **10** (2), 163.—Methyl bromide, ethylene dibromide, acrylonitrile and chloropicrin were applied in the vapor phase, both singly and in admixture with carbon tetrachloride, to the surface of 7-foot columns containing wheat of 12, 16 and 20 per cent moisture content, respectively. Air was used as a carrier gas and the composition of the gas-air mixture that emerged from the bottom of each column was assessed polarographically. Chloropicrin, acrylonitrile and especially ethylene dibromide were strongly sorbed, particularly at 16 and 20 per cent moisture. Even up to 13 days at 25°C., ethylene dibromide emerged only in small amounts and at 4.5°C. was consistantly zero. Acrylonitrile showed an interesting delayed action. Carbon tetrachloride, which in itself is a mediocre fumigant, increased the peak output of each of the other fumigants at the various temperature and moisture levels under test. Carbon tetrachloride also extended the time when zero concentration was reached. The results were in agreement with earlier work with methyl bromide, ethylene dibromide and carbon tetrachloride applied in the liquid phase. It is postulated that carbon tetrachloride vapor may act as an eluting agent, with wheat acting as a chromatographic column. The proportions of acrylonitrile-carbon tetrachloride, chloropicrin-carbon tetrachloride, etc., that emerged from the bottom vary with dosage, time and the temperature and moisture content of the column and, in any event, differ considerably from the proportions initially applied. It follows that biological evaluation of fumigants needs analytical data for correct interpretation of results.

Residue determination of naphthalene-acetic acid and its methyl ester in potatoes by a combination of gas chromatography and ultraviolet spectrophotometry, by Gunter, Zweig, Archer, T. E. and Daniel, Raz., *J. Agric. Fd. Chem.*, 1962, **10** (3), 199.—A method for the determination of residues of naphthalene-acetic acid (NAA) and the corresponding methyl ester (MENA) in potatoes is based on the separation of MENA from interfering plant substances by gas-liquid chromatography and subsequent determination of absorbance of collected fractions at 281 or 224 mμ. The NAA is first esterified with diazomethane to form MENA prior to separation by gas-liquid chromatography. Several varieties of potatoes were treated with MENA, and a decline study of MENA and NAA residues was made for 0 to 90 days after the initial application. The disappearance of MENA residues followed a logarithmic decline curve. Only traces of MENA penetrated the skin of the potatoes. Evidence is presented for the partial hydrolysis of MENA residues to NAA during storage of potatoes.

BIOCHEMISTRY AND NUTRITION

Further evidence of an unidentified, growth-promoting factor (MGF) in cows' milk, by Davis, P. N., Norris, L. C. and Kratzer, F. H., *J. Nutr.*, 1962, **76** (3), 223.—Repeated studies have been made of an unidentified growth factor in milk products (MGF), using the chick as the experimental subject. The factor increased rate of gain significantly ($P < 0.0005$), but the response during the investigation varied from 2.2 to 25.3 per cent with a mean response of 11.6 per cent. In the initial experiment, lactalbumin, lactose hydrate and a combination of these substances promoted a slight response, whereas a marked response was obtained from dried whey and MGF concentrate prepared from the same batch of liquid whey. The variable response appeared to be caused in part by seasonal conditions and in part to the presence of variable quantities of the factor in the soybean protein used in the basal diet. The results of two experiments indicated that, at times, the carbohydrate used in the basal diet influenced the response of the chicks. Dried skim milk was as effective in improving growth as an equivalent level of dried whey.

No improvement in gain was obtained by doubling the quantity of B-group vitamins in the basal diet or by supplementing the diet with ash of dried whey prepared in a manner to minimize loss of minerals by sublimation. The character of the basal diet and the limited amount of protein (mostly non-protein nitrogen expressed as protein) added by the MGF concentrates ruled out the possibility of amino acid deficiency. Contrary to expectations, analyzed reagent grade lactose hydrate was found to promote increased thick gain significantly, but the evidence indicated this was not due to lactose *per se*. MGF is water-soluble, heat-stable resistant to oxidation, not efficiently absorbed by activated charcoal and not absorbed by cation and anion exchange resins during the remova of basic and acidic groups from liquid whey.

Protein synthesis in vitamin B_6 deficiency in the rat, by Hawkins, W. W., Verna G. Leonard and Joan E. Maxwell, *J. Nutr.* 1962, **76** (3), 231.—Young rats were divided into three groups of the same average body weight. Those of one group were deprived o vitamin B_6. The other two groups served as controls. The animals of one control group were fed the same amount of food as those eprived of the vitamin. Those of ie other were maintained at the ıme rate of growth as the vitamin-eprived animals by restriction of ieir food intake.

After 65 days, when growth had een significantly impaired by the itamin deficiency, the protein ontent of the diet of all animals vas adjusted to subject them to uccessive periods of protein depleion and repletion. At each stage f this regimen, the protein and on-protein nitrogen of the liver nd blood plasma were determined n animals from each of the three roups.

Vitamin B_6 deficiency was not ssociated at any stage with signiicant differences among the three roups in the size of the liver, or he concentration of protein in it r in the blood plasma. There was pparently no impairment of the nabolic processes involved in the ynthesis of these proteins.

Inhibitory effect of sulfaguaidine on the biosynthesis of hiamine in rats and the beneicial role of penicillin and hylrolyzed glucose cycloacetoicetate, by Meghal, S. K. and Vath, M. C., *J. Nutr.*, 1962, **76** (3), 265.—When rats were fed sulfaguanidine together with a thiamine-ow basal diet, urinary and fecal hiamine excretion decreased, and he animals showed symptoms of hiamine deficiency; thus an inhibitory effect of sulfaguanidine on he intestinal synthesis of thiamine vas indicated. This inhibitory effect could be overcome by feeding either penicillin or hydrolyzed glucose cycloacetoacetate. Rats thus fed showed an increase in the urinary and fecal excretion of thiamine, with a higher thiamine content in the liver. Inclusion of either penicillin or hydrolyzed glucose cycloacetoacetate promoted better growth with the use of thiamine-low diets. This observation indicates that both compounds enhanced the thiamine synthesis by the intestinal flora and caused an increase in fecal thiamine, which was ultimately available to the rats after coprophagy.

A reinvestigation of methylglyoxal accumulation in thiamine deficiency, by Van Eys, J., Judge, M. A., Judd, J., Hill, W., Bozian, R. C. and Abrahams, S., *J. Nutr.*, 1962, **76** (4), 375.—Thiamine-deficient animals did not excrete large quantities of methylglyoxal, but their tissues accumulated the intermediate when incubated with fructose-diphosphate.

D-Lactic acid was excreted by both normal and thiamine-deficient rats, but the ratio of D/L-lactic acid was significantly greater in deficient animals. The pyruvate/lactate ratio increased in deficient animals, especially the pyruvate/L-lactate ratio.

Since glyoxalase and D-lactate oxidase were present in normal and deficient rats in significant amounts, it was proposed that most formed methylglyoxal was further metabolized to pyruvate and that this pathway is at least partially responsible for increased pyruvate/lactate ratios.

Studies on experimental thiamine deficiency, by Chi-chin Liang, O., *Biochem. J.*, 1962, **83** (1), 101.—Urinary excretion of creatinine in rats during thiamine depletion is fairly constant until a few days before death, but the urinary creatine excretion gradually drops during the first 14 days, on the deficient diet. When the body weight falls, the urinary creatine excretion rapidly increases to a peak after 37-42 days on the deficient diet and drops sharply thereafter until death. Rats given a restricted diet with added thiamine show almost the same pattern of urinary creatinine and creatine excretion.

In rats on thiamine-deficient diet both blood and urinary concentrations of glycine fall at first and then rise steadily until a few days before death.

The rise and fall of concentration of glyoxylic acid in blood and urine reported previously can be correlated with the concentrations of glycine and creatine in blood and urine.

In normal rats, only 15 per cent of the radioactivity of injected (2-^{14}C) glycine was recovered in the expired carbon dioxide. In rats suffering from prolonged thiamine deficiency more than half of glycine radioactivity was recovered in the expired carbon dioxide.

In normal rats, a small fraction of the radioactivity of injected glycine was found in the pyruvate and x-oxoglutarate in the blood and urine but none in glyoxylate. In thiamine-deficient rat, the glyoxylate in blood and urine contained up to 6.9 per cent of the radioactivity from the injected glycine and radioactivity was not found in the pyruvate or x-oxoglutarate.

The present study suggests that the glyoxylate found in blood and urine of thiamine-deficient rats is derived from the glycine liberated by excessive tissue breakdown.

The degradative metabolism of L-cysteine and L-cystine in vitro by liver in cystinosis, by Patrick, A. D., *Biochem. J.*, 1962, **83** (2), 248.—Autopsy samples of liver from three cases of cystinosis have been compared with normal liver with respect to the degradative metabolism of cystine and cysteine, with particular emphasis on the enzymic reduction of cystine.

Under the conditions of these experiments, the reduction of cystine to cysteine by cystine reductase and by glutathione-cysteine transhydrogenase was normal in cystinotic liver. Also, no abnormality was found in the cystine-reductase activity of kidney.

Glutathione-reductase activity and reduced glutathione content of cystinotic liver were normal.

Cysteine, cystine and cysteinesulphinate were completely oxidized by liver of the cystinosis cases, and these findings were substantiated by the normal urinary excretion of inorganic sulphate by cystinosis patients.

The liberation of hydrogen sulphide from cysteine and cystine by cystinotic liver was normal, the reactivity of cystine depending on its prior reduction to cysteine.

No abnormality of cystinotic liver was observed for the transamination of cysteine, cysteic acid and cysteine sulphinic acid with α-oxoglutarate.

Normal decarboxylation of cysteic acid and cysteine sulphinic acid was observed for cystinotic liver.

These findings are discussed with respect to the aetiology of cystinosis.

All-vegetable protein mixtures for human feeding. Part VIII.—biological testing of INCAP vegetable mixture nine in rats [a,b], by Bressani, R., Elias, L. G. and Scrimshah, N. S., *J. Food Sci.*, 1962, **27** (2), 203.—The nutritive value of INCAP vegetable mixture 9 in young and protein-depleted adult rats was studied. This mixture contains 28 per cent lime-treated corn, 28 per cent *sorghum* grain, 38 per cent cottonseed flour, 3 per cent kikuyu leaf meal, and 3 per cent *torula* yeast. When mixture 9, skim milk, casein or meat flour was fed combined with different amounts of starch to give a range of dietary protein levels, the nutritive value of the vegetable mixture for rats compared favourably with that of animal proteins at the higher levels of protein intake. Both young growing rats and protein-depleted rats were used. The growth response was generally less to the vegetable mixture at low protein levels than when animal proteins were fed at the same dietary level, presumably because of a lysine deficiency also observed in previous chick trials.

When the corn and *sorghum* combination was replaced in the mixture by processed corn, *sorghum*, rice, whole wheat or oats, no significant changes were noted in the nutritive value. Furthermore, roasting, boiling, and lime-treating corn and *sorghum* did not affect the nutritive value of the mixture.

Some physico-chemical properties of ribonucleoprotein from rat liver microsomes, by Hamilton, Mary G., Cavalieri, Liebe F. and Petermann, Mary L., *J. biol. Chem.*, 1962, **237** (4), 1155.—Rat liver microsomal ribonucleoprotein particles or ribosomes, were isolated by differential centrifugation after release from the microsomal membranes by 0.5 per cent sodium deoxycholate and purified by a final precipitation with 0.005 M barium acetate or 0.01 M magnesium chloride. The ribonucleoprotein had an anhydrous density of 1.51 g. per ml; the density of zero sedimentation in sucrose solutions was 1.41 g. per ml. The chief difficulties in measuring other physico-chemical properties arose in obtaining the 80-S component free from other components, especially the larger polydisperse aggregates. The intrinsic viscosity was 0.11 dl per g. Zone centrifugation into a sucrose gradient was used to fractionate solutions of ribonucleoprotein for characterization by light scattering. The molecular weight of the 80-S component was found to be 3.6 million, with an estimated uncertainty of approximately 10 per cent.

Purification of the alanine-, valine-, histidine and tyrosine-acceptor ribonucleic acids from yeast, by Apgar Jean, Holley Robert, W. and Merrill Susan, H., *J. biol. Chem.*, 1962, **237** (3), 796.—Procedures are described for the purification of the alanine-, valine-, histidine and tyrosine-acceptor ribonucleic acids (RNA's) by repeated countercurrent distribution, with conditions under which the RNA's are completely stable. The best fractions of three of the RNA's, the alanine-, valine-, and tyrosine-acceptor RNA's are considered suitable for structural studies.

The A protein of the tryptophan synthetase of ***Escherichia coli:*** **Purification, crystallization and composition studies** by Henning, U., Helinski Donald R., Chao, F. C. and Yanofsky Charles, *J. biol. Chem.*, 1962, **237** (5), 1523.—A procedure is described for the isolation and crystallization of the A protein of the tryptophan synthetase of *Escherichia coli.* The isolated protein moves as a single symmetrical component during electrophoresis and in the ultracentrifuge. The isoelectric point was found to be at pH 4.9 to 5.0. A molecular weight of 29,000±500 was calculated from the ultracentrifugal studies. The results of total amino acid analyses are consistent with this value. The protein does not contain tryptophan and possesses three cysteinyl residues one of which exhibits a free sulfhydryl group.

The advantages of this protein for studies of geneprotein relationships are discussed.

The amino-terminal sequence of the A protein of tryptophan synthetase of ***Escherichia coli*** by Carlton Burce C. and Yanofsky Charles, *J. biol. Chem.*, 1962, **237** (5), 1531.—Dinitrophenyl and phenylthiohydantoin end group analysis of the A protein of *Escherichia coli* tryptophan synthetase has suggested that this protein consists of a single polypeptide chain containing an amino-termina methionine residue. Edman degradation of the intact protein has extended the terminal sequence t H_2N-Met. Glu-NH_2. Arg. Tyr Peptides were isolated from tryptic and chymotryptic digests of the protein having the amino acid sequences Met. Glu-NH_2. Arg. and Met. Glu-NH_2. Arg. Tyr., respectively. It is concluded that these peptides represent the amino-terminal sequence of the intact protein

Effect of heat treatment on the nutritive value of proteins chemical and balance studies by Donoso, G., Lewis, O. A. M. Miller D. S. and Payne, P. R., *J Sci. Fd. Agric.*, 1962, **13** (3), 192 —Pork protein heated with an equal weight of water for 24 hrs. a 110 showed losses of dry weight nitrogen, sulphur and all the amino acids. The protein value of the heated material as shown by bioassay fell by a greater extent tha could be accounted for by losses o lysine, available lysine or the sulphur amino-acids. The limiting aminoacids in both original an eated material were the sulphur minoacids. Balance studies of itrogen, sulphur and lysine carried ut concomitantly showed that the all in the utilization of lysine was argely accounted for by a reduction in its digestibility; the falls in utilization of nitrogen and sulphur were mainly due to a reduced retention of the absorbed elements. The results are discussed in relation to possible types of reaction involved in the heat damage of proteins.

Physico-chemical properties of human lactalbumin, by Masahisa Maeno and Isoa Kiyosawa, *Biochem. J.*, 1962, **83** (2), 271.—The separation of lactalbumin from the whey of human milk and its physico-chemical properties are described.

The mobility of lactalbumin was -4.7×10^{-5} cm.^{2} v^{-1} sec.$^{-1}$ at pH 8.5, 10.1, and the electrophoresis patterns were heterogeneous at pH 3.5, but homogeneous at pH 3.0 and 5.5.

A single symmetrical sedimentation boundary of lactalbumin was obtained. The sedimentation coefficient was 1.7 s. and the molecular weight 23,000.

CEREALS

Determination of the moisture content of seeds by near-infrared spectrophotometry of their methanol extracts, by Hart Joe, R., Norris Karl, H. and Golumbic, Calvin, *Cer. Chem.*, 1962, **39** (2), 94. —A rapid, specific, differential spectrophotometric method for determining the water present in methanol extracts of seeds is described. Extracts are prepared by the simultaneous grinding and extracting of the seeds in an enclosed cup by the method of Hart and Neustadt. The absorbance band of water at 1.93 is used. Extracts contain no compounds whose absorbances interfere. Small variations in temperature have no appreciable effect on results. It is necessary that extracts be completely free of suspended material. The standard deviation of the results from those obtained by titration with Karl Fischer reagent is ±0.24 per cent. The method is more rapid than the Karl Fischer method. No expensive reagent is needed and the technique required is less exacting.

Invasion of stored wheat by *Aspergillus ochraceus*, by Christensen, Clyde M., *Cer. Chem.*, 1962, **39** (2), 100.—Wheat was inoculated with *A. ochraceus*, conditioned to different moisture contents, stored at 20°—25°C. and tested periodically. The fungus slowly invaded grain with a moisture content of 15.0—15.5 per cent and rapidly invaded grain with a moisture content of 16.0 per cent and above. A difference of less than 1 per cent in moisture content had a great influence on the rate at which the fungus invaded the grain. The fungus grew mainly in the embryo, causing its death and decay. *A. ochraceus* was able to invade only a small percentage of kernels in which *A. glaucus* already was established.

Protein-bound sodium and potassium in some grains, by Roychowdhury, S. P., *J. Food Sci.*, 1962, **27** (3), 242.—Eight grain species were examined for sodium and potassium contents in protein and non-protein fractions before and after soaking. Most of sodium is protein bound and potassium appears less strongly bound. Soaking does not seem to change these constituents in two fractions. Hardly any salt appears to leach out in soaking.

Characterization studies on the soluble proteins and pentosans of cake flour, by Holme John, *Cer. Chem.*, 1962, **39** (2), 132.—Bleached cake flour (1.32 per cent nitrogen; 14 per cent moisture basis) has been extracted by various aqueous solvent systems to determine the percentage of the total flour protein solubilized under each condition. The effect of factors such as solvent: flour ratio, mixing time, pH, ionic strength, and alcohol concentration upon the amount of soluble protein has been determined. The albumin content of the flour represents about 10 per cent of the total flour protein. The aqueous extracts contain soluble pentosans in addition to the protein. The constituents have been isolated by salt fractionation techniques and characterized by moving boundary electrophoresis and ultracentrifugation. The pentosan fraction (containing about 5 per cent protein) appears to be homogeneous in electrophoresis and sedimentation. The albumin fraction contains at least five electrophoretic components which are also polydisperse in sedimentation characteristics.

Evaluation of colour characteristics of the flours obtained from various types and varieties of wheat, by Yasunaga Takashi and Uemura, Mitsuo, *Cer. Chem.*, 1962, **39** (3), 171.—Colours of flours obtained from various types and varieties of wheat were studied spectrophotometrically. The samples represented western white and dark hard winter wheat from the U.S.A., red spring wheat from Canada, wheat from Western Australia and some varieties of Japanese domestic wheat. Colour characteristics are reported in C.I.E. chromaticity coordinates derived from spectral reflectance curves. At the same levels of ash content, western white flours showed the highest luminosity and the lowest excitation purity, while Japanese domestic wheat flours showed the lowest luminosity and the highest excitation purity. Differences in hue were also observed among these types of wheat.

Content of yellow pigments and the amount of residual pigment when bleached, varied with type or variety of wheat. These factors have a major influence on the excitation purity.

Addition of benzoyl peroxide brought little improvement to bran colour. Variations in luminosity and hue are caused not only by the different degree of bran contamination but also by the difference in bran colour among the various wheat sources.

Two indices, derived from reflectances at some particular wave lengths, were proposed for evaluating flour colour: one, for the content of yellow pigments and the other, for the coloration by the contaminating bran. Using these indices, it is possible to show, regardless of the degree of bran contamination, the colour characteristics of flours from different samples of wheat.

A rapid method for the extraction of lipids from wheat products, by Tsen, C. C., Levi, I. and Hlynka, I., *Cer. Chem.*, 1962, **39** (3), 195.—A rapid method of extracting lipids from animal tissues by means of phase partition of a ternary mixture of chloroform, methyl alcohol and water was proposed originally by Polch *et al.* The method has been adapted in this study for the extraction of lipids from wheat products. The modified method is especially useful for studies in which it is necessary to isolate the lipids with minimum changes. The method extracts practically the same amount of lipids from flour and from a corresponding dough or dried dough. For the estimation of lipid content of wheat products, if yields results comparable with those obtained by ethyl or water-saturated n-butyl alcohol extractions or by acid hydrolysis extractions, but gives higher lipid values than petroleum-ether extractions.

The role of lipids in oxidation of doughs, by Tsen, C. C. and Hlynka, I., *Cer. Chem.*, 1962, **39** (3), 209.—Results obtained with the thiobarbituric acid method on lipids extracted from flour provide direct evidence that lipid peroxides are formed in dough during mixing in air or oxygen. Doughs mixed in air or oxygen gave a higher absorbance in the TBA test than did control doughs mixed in nitrogen. Addition of lipoxides in the form of 'Wytase' also increased the rate of peroxidation of flour lipids. On the other hand, addition of NDGA or propyl gallate as antioxidants to flour inhibited the peroxidation essentially to the level of doughs mixed in nitrogen.

Succinic acid peroxide, t-butyl hydroperoxide, hydrogen peroxide, acetyl peroxide and methyl ethyl ketone peroxide all increased the structural relaxation constant of dough, indicating a similar improving role for flour lipid peroxides.

When sulfhydryl-blocking reagents (PCMB, IAA, $HgCl_2$ and NEMI) and improving agents (iodate and bromate) were incorporated into dough, lipid peroxidation was increased. This suggests that flour lipids compete with sulphydryl groups for available oxygen in doughs.

On the basis of these findings a unified hypothesis for the role of lipids in oxidation of doughs is presented and discussed.

Carotenoids of corn and *sorghum*: Part I.—analytical procedure by Blessin, C. W., *Cer. Chem.*, 1962, **39** (3), 236.—An improved procedure for determining total carotenes and total xanthophylls was developed to serve as a basis for studying the variation of carotenoid pigments in corn and *sorghum*. The method, based on chromatography and spectrophotometry, is also applicable to grain fractions from wet or dry milling. The effectiveness of alcohols as extracting solvents is attributed to their wetting action and to the breaking of carotenoid-protein complexes. The method produces a sharp separation of carotenes from free xanthophylls. The carotenes fraction includes cryptoxanthin esters, which comprise 13 to 33 per cent of the carotenes and 1-5 per cent of the total carotenoids in corn and *sorghum*. Saponification is unnecessary in studies on gross variation in xanthophyll level in cereal grains. Relative amounts of non-carotenoid pigments are also estimated by the improved procedure. Other factors influencing the determinations are discussed.

Grain storage studies: Part XXXII.—quantitative changes occurring in the sugars of wheat deteriorating in the presence and absence of molds, by Lynch, B.T., Glass, R. L., and Geddes, W. F. *Cer. Chem.* 1962, **39** (3), 256.—Sound wheat (germination 98 per cent) was stored in atmospheres of air, nitrogen or carbon dioxide for 8 weeks at 30°C and 20 per cent moisture. By most of the criteria used, those samples stored in anaerobic conditions and hence without mold growth, deteriorated almost as rapidly and equally in degree as did a sample stored in aerobic conditions. All samples exhibited zero germination, had undergone extensive changes in sugar content, and gave flour of extremely poor baking quality after 8 weeks. The exception was fat acidity which remained constant under anaerobic conditions while increasing tenfold under aerobic conditions.

In air, the sucrose content of wheat decreased markedly, whereas little change occurred in glucose, fructose, galactose or maltose content. In carbon dioxide and nitrogen, the sucrose content decreased and rather large increases in glucose, fructose and galactose occurred.

COCOA

Studies on the volatile components of different varieties of cocoa beans, by Bailey, S. D., Mitchell, D. G., Bazinet, M. L. and Weurman, C., *J. Food Sci.*, 1962, **27** (2), 165.—Volatile compounds in the aroma of five varieties of roasted and unroasted (raw) cocoa beans have been identified by mass spectral analysis and gas chromatography. The five common varieties selected for this study all contain the following compounds usually in this order of abundance: isovaleraldehyde, isobutyraldehyde, propionaldehyde, methyl alcohol, acetaldehyde methyl acetate, n-butyraldehyde, and diacetyl. An additional eight compounds appear in smaller amounts. As evidenced by gas chromatographic analysis, the raw bean aroma contains the same components but in lower concentraons. The principal differences etween varieties are shown to be ue to the ratios of these compounds ather than new compounds. The ffect of roasting period on the oncentration of four aldehydes in he aroma of the ground bean is hown.

DEHYDRATION

The molecular oxygen content of dehydrated foods, by idwell, C. G., Harold, Salwin nd Robert, B. Koch, *J. Food Sci.*, 962, **27** (3), 255.—A polarographic method for measuring the molecular oxygen content of foods is described. Oxygen contents determined by the method were of the same order of magnitude as peroxide oxygen values of non-rancid fats and oils. Factors that controlled the molecular oxygen content of dehydrated foods were per cent moisture, surface area, partial pressure of oxygen, and absorbability of other gases in the headspace.

ENZYMES

Peroxidase regeneration and its effect on quality in frozen peas and thawed peas, by Pinsent, B. R. W., *J. Food Sci.*, 1962, **27** (2), 20.—Peroxidase was regenerated in samples of peas that had been blanched just sufficiently to destroy the original peroxidase activity. The regeneration occurred after a few months in peas stored at 18°C, or within a few hours in thawed peas held at room temperature. The maximum activity regenerated was about 4 per cent of the original activity. No regeneration occurred in peas given substantially more heat treatment than was needed for inactivation. Peroxidase regeneration during frozen storage, or after thawing, did not affect the quality of peas.

Stability of spinach catalase: Part I.—purification and stability during storage, by Sapers, G. M. and Nickerson, J. T. R., *J. Food Sci.*, 1962, **27** (3), 277.—Some of the variables influencing the stability of purified and unpurified spinach catalase during storage were evaluated in model systems. A purified preparation of spinach catalase was obtained from spinach leaves by comminution and extraction with phosphate buffer and extraction with n-butanol, $(NH_4)_2SO_4$ precipitation, $(NH_4)_2SO_4$ fractionation, dialysis, and lyophilization. The preparation had a Kat.-f. of 3300 at pH 7.0. The stability of the enzyme in storage was influenced primarily by storage temperature, the pH of catalase solutions, and the activity of microorganisms. The enzyme concentration had a relatively minor effect on catalase stability. The stability of spinach catalase during storage was not influenced by the presence of NaCl, sucrose, starch and denatured catalase in catalase solutions; the atmospheric pressure under which solutions were stored; or differences in freezing rates.

Stability of spinach catalase: Part II.—inactivation by heat, by Sapers, G. M. and Nickerson, J. T. R., *J. Food Sci.*, 1962, **27** (3), 282.—The effects of certain variables on the thermal stability of spinach catalase were investigated with model systems. The rate of thermal inactivation of spinach catalase was accelerated as heating temperature was increased. Inactivation kinetics were not first-order with solutions of the purified enzyme between 50 and 60°C and with spinach extracts at 55°C, but became first-order with the latter preparation as the temperature was increased to 65°C. The presence of a heat-liable catalase inhibitor is postulated. Catalase was more thermostable in spinach extracts than in solutions of the purified enzyme. Purified spinach catalase at 55°C was more thermostable in solutions at pH 5.5 and 7.0 than at pH 9.0. The thermostability of purified spinach catalase was not influenced by the enzyme concentration or by the presence of 1.5 per cent NaCl, 3.6 per cent sucrose or 3.6 per cent starch in pH 7.0 solution at 55°C.

Stability of spinach catalase: Part III.—regeneration, by Sapers, G. M. and Nickerson, J. T. R., *J. Food Sci.*, 1962, **27** (3), 287.—The regeneration of spinach catalase was demonstrated during storage after heat inactivation. The occurrence of regeneration was influenced by the enzyme source, pH, heating conditions and storage conditions. The change in catalase activity after heating was considered to represent the balance between enzyme regeneration and enzyme inactivation during storage.

Pectin methylesterase in snap beans, by Van Buren, J. P., Moyer, J. C. and Robinson, W. B., *J. Food Sci.*, 1962, **27** (3), 291.—Snap bean pectin methylesterase had a pH optimum of 8.2. Its activity was enhanced by the presence of salts such as sodium chloride and calcium chloride. Low pH conditions increased the susceptibility of the enzyme to heat inactivation. There were indications that conditions were present in the intact pod which protected the enzyme from heat denaturation. The enzyme had a Q_{10} of 1.4 over a wide temperature range. It was not regenerated on frozen storage.

Separation and purification of the phenolases of the common mushroom by Smith Jack, L. and Krueger, R. C., *J. biol. Chem.*, 1962, **237** (4), 1121.—Purified phenolase (tyrosinase) fractions have been separated from aqueous extracts of the common mushroom by calcium phosphate gel adsorption and elution and by column chromatography on hydroxylapatite and DEAE-cellulose. Column chromatography of the crude extracts has indicated the occurrence of several enzyme types, among which were the classical high catecholase and high cresolase enzymes.

Only partial purification of the high cresolase type was obtained by exhaustive calcium phosphate gel adsorption methods. On the other hand, chromatography on hydroxylapatite and DEAE-cellulose has led to the separation and purification of both the high catecholase and the high cresolace types of enzymes. Column chromatography and starch gel electrophoresis have indicated that the high catecholase enzyme was homogeneous but that the high cresolase enzyme was multicomponent in nature. The several enzyme types are considered to occur naturally and are not the result of degradation or fragmentation of a single, original native enzyme.

The deoxyribonucleases of ***Escherichia coli:*** **Part II.—purification and properties of a ribonucleic acid-inhibitable endonuclease** by Lehman, I. R., Roussos, G. G. and Pratt, E. A., *J. biol. Chem.*, 1962, **237** (3), 819.—An enzyme which attacks native deoxyribonucleic acid has been purified approximately 600-fold from extracts of *Escherichia coli.* It has the following properties: (*a*) It degrades native deoxyribonucleic acid at a 7-fold greater rate than thermally denatured deoxyribonucleic acid. (*b*) It carries out an endonucleolytic attack on deoxyribonucleic acid, yielding a limit digest whose oligonucleotides have an average chain length of approximately 7; these are terminated by a 5^1-phosphoryl group. The isolated oligonucleotides are neither cleaved by high concentrations of enzyme, nor can they, when added in equal concentrations, inhibit the hydrolysis of deoxyribonucleic acid. (*c*) It exists in the crude extract bound to an inhibitory ribonucleic acid which is removed during purification.

The deoxyribonucleases of ***Escherichia coli:*** **Part III.—studies on the nature of the inhibition of endonuclease by ribonucleic acid,** by Lehman, I. R., Roussos, G. G. and Pratt, E. A., *J. biol. Chem.*, 1962, **237** (3), 829.—The *Escherichia coli* endonuclease is found in extracts bound to an inhibitory ribonucleic acid.

1. When purified, this enzyme is free of inhibitor and can be inhibited by a variety of ribonucleic acids from *Escherichia coli*, guinea pig liver, and tobacco mosaic virus. Of those tested, the amino acid acceptor ribonucleic acid from *Escherichia coli* is the most active. The kinetics of the enzyme inhibited by the amino acid acceptor ribonucleic acid obey the equations for a competitive inhibition and the calculated K_i is of the order of 1×10^{-8}M (ribonucleic acid nucleotide).

The ribonucleic acid-like polynucleotides synthesized by polynucleotide phosphorylase are essentially inactive as inhibitors, as is high molecular weight polyphosphate.

The activity of other deoxyribonucleic acid-cleaving enzymes, including pancreatic deoxyribonuclease and the *E. coli* and snake venom phosphodiesterases, is not affected by ribonucleic acid.

Other basic proteins such as cytochrome *c*, when present in great excess, do not prevent the inhibition of the endonuclease (also a basic protein) by amino acid acceptor ribonucleic acid.

The relevance of these observations to the changes in over-all deoxyribonuclease activity after phage infection of *Escherichia coli* is discussed.

Studies on α-amylase formation by ***Bacillus subtilis*** by Coleman, G. and Elliott, W. H. *Biochem. J.*, 1962, **83** (2), 256.—α-Amylase formation has been studied in growing cultures of *Bacillus subtilis* and a requirement for Fe^{3+} ions demonstrated.

The distribution of α-amylase between the extra- and intracellular phases in washed-cell suspensions that were actively producing the enzyme has been examined. The cell-bound α-amylase remained constant at a low value whereas the extra-cellular enzyme rapidly increased in amount. The failure of the cells to accumulate α-amylase supports the concept that this enzyme is 'secreted' as a truly extra-cellular product.

Formation of the enzyme by washed-cell suspensions of *B. subtilis* is stimulated by a carbohydrate source and to a much lesser exten by NH_4^+ ions. Amino acids ar inhibitory.

Formation of α-amylase b washed-cell suspensions is strongl inhibited by anaerobiosis, 2, 4 dinitrophenol, chloramphenicol and to a small extent, by *p*-fluorophenyl alanine.

The relationship of these result to the mechanism of α-amylas formation and to the findings c previous workers is discussed.

ESSENTIAL OILS

Isolation and identification c aldehydes in cold-pressed lemo oil by Ikeda, R. M., Rolle, L. A Vannier, S. H. and Stanley, W. L *J. Agric. Fd. Chem.*, 1962, **10** (2 98.—An investigation of the ald hydes of lemon oil has establishe the presence of octanal, nonanal, d canal and undecanal by bot infra-red spectra and preparatio of solid derivatives. Heptanal w identified by melting point an infra-red spectrum of its 2, dinitrophenylhydrazone. Citr nellal, neral and geranial wer identified by melting points ar mixed melting points of their 2, dinitrophenylhydrazones. Dodec nal, tridecanal, tetradecanal, per tadecanal, hexadecanal and hept decanal were tentatively identifie by gas chromatography using a pl of log retention time *vs.* number carbon atoms for five colum packing. Retention times on fo stationary phases indicated th presence of hexanal.

Isolation and identificatio of some volatile carbonyl com ponents from orange essenc by Attaway John, A., Richar Wolford, W. and Edwards Georg J., *J. Agric. Fd. Chem.*, 196 **10** (2), 102.—An analytical pr cedure is described for the dete tion and identification of carbon components in trace amounts fro a commercial orange essenc Volatile organic components we separated as an oil by liquid-liqu extraction of the essence a fractionated by gas-liquid chrom tography. Carbonyl peaks we tected by bubbling the effluent s through on ethanolic solution 2, 4-dinitrophenylhydrazine sul- e and identified by their dini- phenylhydrazones. Carbonyl mponents identified include acet- lehyde, hexanal, hexenal (two mers), octanal, octenal (?), fur- ral (?) neral, geranial and car- ne.

LAVOURS

Recent contributions of colour d flavour research to food chnology, by Livingston, G. E., *anad. Food Industr.*, 1962, **33** (3), .—With the advent of improved strumentation techniques it has come possible to carry out in- easingly more meaningful and warding research on food colour d flavour. Methods for their mea- rement have become more sensi- ve, complex and valuable. The uestion posed is, 'how has the search in the areas of flavour and lour benefited the manufacturers'. colour research there are two ajor areas of interest. The first ncludes the chemical identification nd the second deals with the hysical aspect of the colour of the od products. The object of most olour studies is to determine the olour attribute which most closely orrelates with sensory colour eva- ation and also to define the nume- ical limits corresponding to various rades, qualities, stages of maturity, tc.

Flavour research covers the iden- ification of chemical components hat contribute to the flavour of he product and the measurement f the flavour using sensory panels. The classical accomplishments of he research in recent years refer o the analysis of black pepper to determine the volatile components by a combination of various separation and identification techniques. Equally impressive is the work carried out on the composition of coffee flavour which was made possible only through the advent of gas-liquid phase chromatography. Using this remarkable tool, it has been possible not only to separate and identify the volatiles present, but also to differentiate between different types of coffee and to study the effects of processing and storage factors on volatile composition. Similarly large collection of information on the chemical compounds contributing to the flavour of the dough and bread before and after baking has been made possible.

It may, however, be emphasised that colour and flavour analysis by instrumental means should not allow anyone to conclude that the days of sensory panel evaluation are over. On the other hand, the two are mutually complementary.

—R.C.B.

Complexity of flavour and blending of wines, by Singleton, V. L. and Ough, C. S., *J. Food Sci.*, 1962, **27** (2), 189.—Thirty-four pairs of similar, commercially acceptable wines and a freshly prepared 50-50 blend of each pair were scored for quality by a small expert panel. The composite scores of the blends did not differ to even a low degree of significance from the score of the highest—scoring member of the pair. The scores of the blends were very highly significantly better than the scores for the low-scoring wines or the mean of the low—and high-scoring wine in each pair. In 7 cases among the 34, the blend's composite score was higher than that of the highest-scoring wine and in no case was it lower than that of lowest-scoring wine of the pair. Increased complexity of flavour is believed to be a major factor in the favourable effect of blending shown in this study; other possible effects are discussed.

Determination of odor difference thresholds, by Stone, H., Ough, C. S. and Pangborn, R. M., *J. Food Sci.*, 1962, **27** (2), 197.—An olfactometer described previously was modified and used to determine odor-difference thresholds for 48 subjects at 4 levels of 2-heptanone. The apparatus was found to give rapid and reproducible threshold measurements. Difference thresholds were found to follow the Weber law. A Weber fraction of 0.23 mg/min/ deviate was determined for 2-heptanone. The absolute threshold was found to be 8.97×10^{-4} mg. of 2-heptanone/litre air.

FROZEN FOODS

The effect of storage at elevated temperature on some proteins of freeze-dried beef, by Cole, L. J. N., *J. Food Sci.*, 1962, **27** (2), 139.—In an attempt to determine the effect of oxygen and elevated temperature on freeze-dried beef in a moisture-free atmosphere, two series of storage experiments were conducted on freeze-dried beef slices. In one *longissimus dorsi* muscle, and in the other *semitendinosus*, was packaged under commercially feasible conditions where the residual gas contained 2.5±0.5 per cent oxygen and no atmospheric moisture. An in-can desiccant, calcium oxide (CaO), and an oxygen scavenger, Oxygen (glucose oxidase), were added in some instances, and the cans were stored up to 6 months at 100°F.

In each series there was marked loss in extractability of actomyosin, and in activity of actomyosin ATPase after 1 month, but only a 40 per cent loss of sarcoplasmic proteins. The residual aldolase activity decreased progressively to 8 per cent at 6 months whereas the residual water soluble portions decreased progressively only to 56 per cent. There was a marked difference between the two series in per cent rehydration at 6 months; 81.1 in one, and only 26 in the second. Electrophoresis of the sarcoplasmic proteins showed gross denaturation after 1 month at 100°F.

The use of antioxidants in frozen whole milk by Gelpi, Jr. A. J., Rusoff, L. L. and Pineiro, Enrique, *J. Agric. Fd. Chem.*, 1962, **10** (2), 89.—Various antioxidants—ethyl hydrocaffeate, gentisic acid, sodium gentisate and lonol—were tested with whole milk at —10°F. for a 6-month storage period with and without the addition of copper. All compounds, with the exception of lonol, showed good antioxidant properties, the sodium gentisate being superior to the others. Lonol imparted an off-flavour to the milk and precipitated the milk proteins. By use of proper antioxidants and storage conditions, frozen whole milk may be kept in good condition for at least 6 months.

FRUITS AND VEGETABLES

Effect of processing temperature on pigments and color of spinach, by Tan, C. T. and Francis F. J., *J. Food Sci.*, 1962, **27** (3), 232.—A method was developed for estimation of chlorophylls *a* and *b*, pheophytins *a* and *b*, lutein and carotene in processed spinach. The method, developed primarily for colorimetric studies, involves extraction of the spinach with acetone and chromatographic separation on a sugar-starch (70:30) column. Equations were developed for spectrophotometric estimation of the amount of each pigment in the eluate from the column. The method gave recovery values of 95-98 per cent for a wide range of pigment mixtures, and a co-efficient of variation of approximately 1.5 per cent for reproducibility on the same extract.

Fresh spinach was blanched, pureed, packed in glass thermal-death-time tubes and processed in an oil bath at 240, 250, 260, 270 and 280°F for a process value equal to Fo 4.9 Color measurements indicated a difference of 4.1 units between the controls and the samples processed at 280°F, and 11.6 units between the controls and the sample processed at 240°F. The pigment changes indicated a progressively smaller change in chlorophylls *a* and *b* to pheophytins *a* and *b* as the processing temperature was raised. Chlorophyll *a* was degraded more rapidly than chlorophyll *b*, and the ratio of the two changed from 1.55 for the samples processed at 280°F, to 0.92 for the samples at 240°F. Some degradation of lutein was observed, particularly at the lower processing temperatures, where as carotene was unchanged. The pigment-free tissues also showed more change in color at the lower temperatures, but the contribution of the pigment-free tissues and the degradation of lutein to the over-all color change was very small. The major reasons for the change in color of the spinach puree upon processing were, first, the degradation of chlorophyll *a* to pheophytin *a*, and second, the degradation of chlorophyll *b* to pheophytin *b*.

Composition of tomato fruit: Part IV.—changes in some constituents of the fruit walls during ripening, by Winsor, G. W., Davies, J. N. and Massey, D. M., *J. Sci. Fd. Agric.*, 1962, **13** (3), 1. —Changes in the composition of the outer walls of glasshouse tomatoes during ripening have been studied. The fruit, mainly of the variety 'Potentate', was carefully graded by colour into either five or six categories from mature green to red.

The content of sugars and total solids in the expressed juices increased significantly from the green to the red stage. The nitrogen content showed little variation from the green to the orange stage, but increased significantly on reaching the fully red condition.

The titratable acidity of the juices increased significantly from the green to the green-yellow stage of ripeness, accompanied by decreasing pH. No consistant changes in acidity could be established after the first appearance of yellow colour, the acidity rising in some series and decreasing in others. A tentative explanation of this behaviour, which differs from that of the juices from the locules and from the whole fruit, is discussed.

Composition of tomato fruit: Part V.—comparison of the differently coloured areas of the walls of 'blotchy' tomatoes, by Winsor, G. W., Davies, J. N. and Massey, D. M., *J. Sci. Fd. Agric.*, 1962, **13** (3), 145.—A comparativ study has been made of some components of the green and red areas o the walls of 'blotchy' tomatoes. Th juices expressed from the green areas showed a significantly lowe titratable acidity than those from the red areas, and had a lower content of sugars and nitrogenou compounds. Juices from the green areas also contained less solubl solids, as determined by oven drying and had lower refractiv indices.

The content of ethanol-solubl total sugars and free and tota acids was significantly lower in th green than in the red areas. Th proportion of alcohol-insolubl solids was higher in the green areas

The results are discussed i relation to the changes in composition previously found durin ripening. Some aspects of th results suggests that 'blotch ripening' cannot merely be attributed to delayed ripening in th affected areas.

VITAMINS

Naturally occurring forms o folic acid: Part II.—enzymati conversion of methylenetetrahydro folic acid to prefoli A-methyltetrahydrofolate, b Donaldson Kenneth, O. an Keresztesy John, C., *J. biol. Chem* 1962, **237** (4), 1298.—Prefolic A i enzymatically oxidized to hydroxy methyl tetrahydrofolic acid. Th partially purified enzyme is flavi adenine dinucleotide-linked an requires menadione as electro acceptor. Other quinones an certain low potential dyes will als serve as electron acceptor. Reduce diphosphopyridine nucleotide competitively inhibits the formation o tetrahydrofolic acid from prefoli A. Neither disphosphopyridin nucleotide nor triphosphopyridin nucleotide will serve as electro acceptor.

In the presence of the same enzyme preparation, prefolic A is synthesized from tetrahydrofolic aci and formaldehyde (or methano with reduced diphosphopyridin cleotide or reduced triphosopyridine nucleotide as election nor. Menadione competitively hibits the biosynthesis of prelic A. Mechanisms for the forard and reverse reactions are scussed. Prefolic A is characterid as an N^5-methyltetrahydrofolic id.

The function of vitamin B_{12} in ie metabolism of propionate y the protozoan *Ochromonas alhamensis*, by Arnstein, H. . V. and White, A. M., *Biochem.* , 1962, **83** (2), 264.—The effect f vitamin B_{12} on the oxidation of 4C] glucose, [^{14}C] formate, [^{14}C] cetate and ^{14}C propionate by vitahin B_{12}-deficient cell suspensions f *Ochromonas malhamensis* has een studied.

The oxidation of glucose, formate nd acetate is affected little or not t all, but in the absence of vitamin $_{12}$ there is a virtually complete lock in the oxidation of propionate. Addition of cyanocobalamin apidly stimulates propionate oxidaion to a very marked extent.

Several analogues of cyanocoalamin have been tested for their effect on propionate oxidation and their activity has been compared with their ability to promote growth.

Whereas most compounds were either inactive or active in both tests, the methylamide analogue stimulated propinnate oxidation but inhibited growth and 5-hydroxybenzimidazolylcobamide (vitamin B_{12}III) stimulated growth but increased propionate oxidation only slightly.

It is concluded that, in addition to its function in the propionate-methylmalonate-succinate pathway, vitamin B_{12} is involved in another reaction which is important for the growth of this organism and possibly of animals also.

Ascorbic acid oxidation and lipid peroxidation in milk, by Grafton Smith J. and Dunkley, W. L., *J. Food Sci.*, 1962, **27** (2), 127.—Ascorbic acid oxidation was studied in relation to the natural copper level and to lipid peroxidation in milks produced by cows receiving alfalfa hay or pasture. Correlations were highly significant (r=0.79***) between ascorbic acid oxidation rate and natural copper for both alfalfa and pasture milks. The correlation between lipid peroxidation (by the TBA test) and ascorbic acid oxidation rate was very highly significant (r=0.87***) in alfalfa milks but nonsignificant in pasture milks.

Some postulated mechanisms for the action of copper and ascorbic acid in producing oxidized flavour were studied. The results do not support the theories of the role of the ascorbic acid radical, or of hydrogen peroxide, in the initiation of oxidized flavor.

The kinetics of ascorbic acid oxidation by light, hydrogen peroxide, and ascorbic acid oxidase were examined. Zero-order kinetics was found for light, and first-order for the other agents.

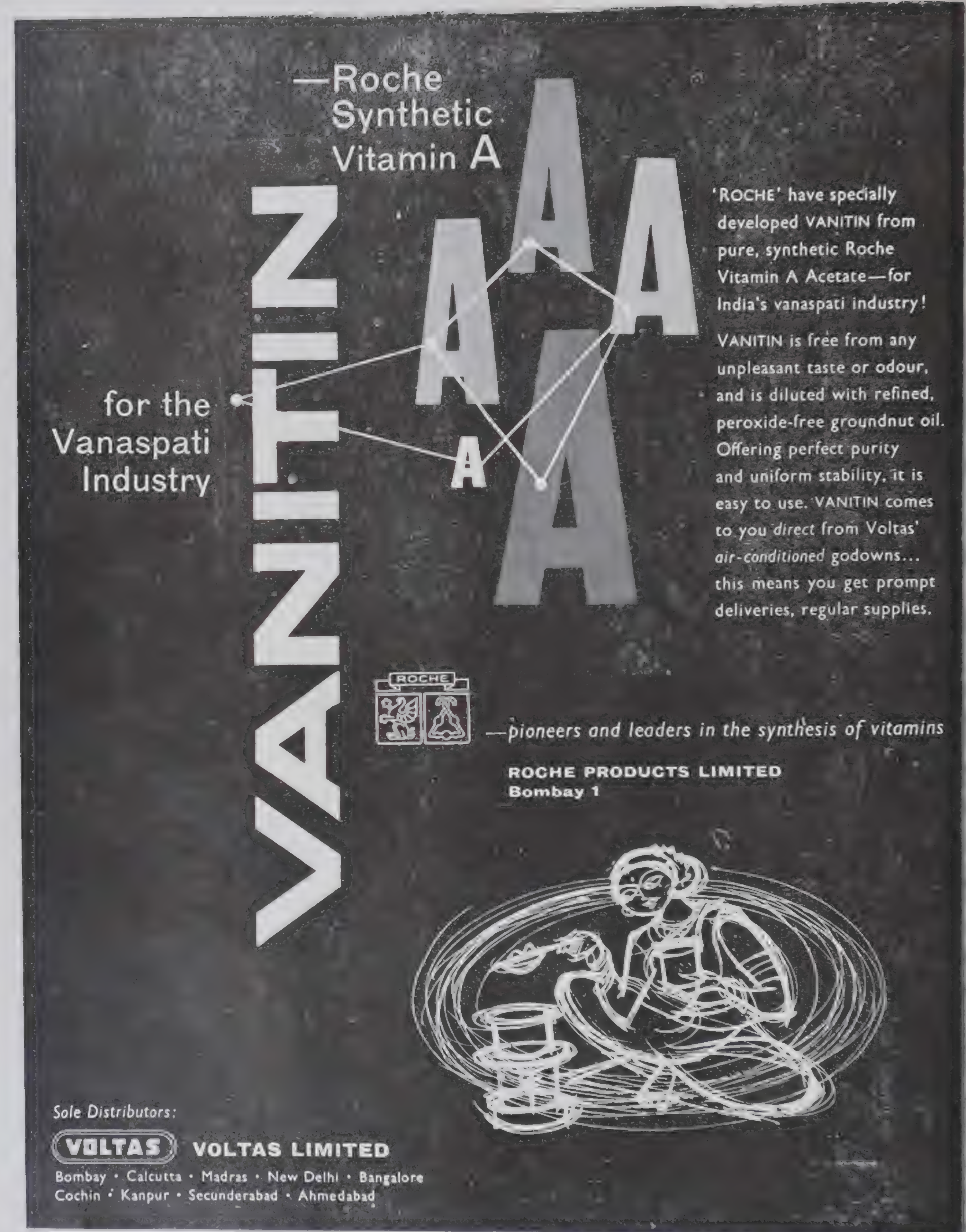
Enzymatic oxidation of vitamin A aldehyde to vitamin A acid, by Futterman Sidney, *J. biol. Chem.*, 1962, **237** (3), 677.—Vitamin A aldehyde is oxidized to vitamin A acid by liver aldehyde dehydrogenase, liver aldehyde oxidase, and milk xanthine oxidase. No evidence for the reversibility of these reactions could be obtained.

HOME-SCALE PREPARATION OF FRUITS AND VEGETABLES (Revised edition)
(*published in September, 1962*) Royal 8vo, P. 46. (*Editors:* J. V. Shankar, R. C. Bhutiani, H. C. Bhatnagar, A. Rahman, G. S. Siddappa and K. Indiramma).

This publication brings together under one cover the different methods of preparation and preservation of fruits and vegetables that can be practised on a domestic-scale together with the information about the equipment necessary and the places of their availability.

Methods of canning, bottling and drying of fruits and the preparation of jams, jellies, marmalades and syrups from them are described in general terms in addition to the descriptions, under each fruit, of the methods of their utilization with recipes for various products. Instructions for the different methods of processing vegetables are given under a separate head which is followed by those for making pickles, spiced carrot juice, ginger preserve and candy, and petha candy. A glossary gives the vernacular names of other fruits, vegetables and spices used in these preparations.

In short, the publication is designed for use by housewives, community development workers, home science students and cottage-scale manufacturers.



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STUDIES ON THE BREWING OF TEA

C. P. Natarajan, S. Ramamani, D. E. Leelavathi, R. Shakunthala, D. S. Bhatia and V. Subrahmanyan

(*Central Food Technological Research Institute, Mysore*)

Very little basic scientific data are available n the technology of brewing of tea. Punnett[1] eported that a brewing temperature of 82.2°C epresents the dividing line between flavour-ful nd dull tea. The time of contact, of course, aries with temperature of brewing and he eported the equivalent brewing times as 3, 4, 5 nd 8 minutes for constant brewing temperatures f 200°F (93.3°C), 195°F (90.6°C), 190° (87.8°C) nd 180°F (82.2°C) respectively. He also stress-d the importance of correct measure for tea nd demonstrated the variations occurring with ea measured with level tea spoon and rounded ea spoon[2]. The minerals affecting the tea aste have also been reported[3]. Some data on annins, caffeine and soluble matter in 5 minutes nfusion have been presented[4].

In general, brewing is influenced by the actors: (*i*) *Nature of raw material*—its freshness, article size and inherent quality of the blend; *i*) *Nature of the extracting water*—its purity, emperature; (*iii*) *Time of infusion and ratio* etween the weight of tea and volume of water; *iv*) *Brewing device*—its design, material of onstruction and efficiency of extraction under ifferent capacities, rate of cooling and method of rewing; (*v*) *Addition of other substances* such as ugar, milk etc.; (*vi*) *Taste preference* of the con-umer.

The extraction rates of different constituents n tea with water at different temperatures and ime, the inherent variations in the brewing haracteristics of different grades of tea, the ffect of different ratios of tea to water, the in-fluence of prewetting tea before extraction, the ffect of prewarming the pot before brewing, he influence of brewing in a given pot at different apacities, the normal cooling of water occurring uring brewing etc., have been studied and the resent report describes the results obtained.

Experimental

Material: The samples of tea for these studies were obtained from a tea estate, the different grades being drawn from the same bulk manufacture. The grades were: Broken Pekoe (B.P.), Broken Orange Pekoe (B.O.P.), Fannings (F) and Dust. In one of these studies a market blend of Broken Orange Pekoe grade was used. The sieve analysis of different grades were also determined (Table I).

Preparation of the brew: The brews were prepared in glass beakers with distilled water as described in subsequent sections.

(*a*) *Different ratios of tea to water:* The brews were prepared using 5 g. lots of tea (B.O.P.) by steeping for 6 minutes with different volumes of boiling water (50, 100, 150, 175, 200, 225, 250, 300 and 400 ml.). The brew was filtered and the volume obtained recorded. After making up to suitable volume, 100 ml. aliquots were used for the estimation of total soluble solids (Table II and Fig. 1).

(*b*) *Different grades vs. extraction:* Using Broken Pekoe, Broken Orange Pekoe, Pekoe,

TABLE I. *Sieve analysis of different grades of tea*

Grade	B.S. Mesh No.									
	10		18		25		30		36	
	Percentages									
	Retained	Passed through	Retained	Passed through	Retained	Passed through	Retained	Passed through	Retained	Passed through
Broken Pekoe	54	...	44	2	...	...	...	...	...	...
Broken Orange Pekoe	...	...	94	6	...	...	...	...	...	...
Fannings	...	...	...	...	32	...	31.3	...	16.3	20.4
Dust	...	...	...	...	...	...	7	...	25.7	67.3
Broken Orange Pekoe market blend	...	...	84.2	...	11.3	...	2.2	2.3	...	...

TABLE IV. *Extraction rates of some constituents in different grades of tea as per cent of total solids*

Constituents	Time in minutes	Grade		
		Broken Pekoe	Broken Orange Pekoe	Dust
Total solids% (moisture free basis) ...	2	22.60	24.67	34.40
	4	25.95	28.54	34.73
	6	26.71	30.56	35.02
	8	28.00	31.14	35.30
	10	28.20	33.04	35.78
	as per cent total soluble solids			
Minerals ...	4	...	7	7
	6	...	8	9
	8	...	7	10
	10	...	8	10
Tannins ...	2	26	28	39
	4	30	30	40
	6	30	33	41
	8	32	34	41
	10	34	...	43
Caffeine ...	2	...	13	13
	4	12	13	12
	6	12	12	12
	8	13	12	12
	10	14	12	12
Non-caffeine nitrogen ...	2	2.0	2.9	2.8
	4	2.4	3.1	2.9
	6	2.7	3.2	3.1
	8	2.9	3.0	3.1

These conditions were found to be optimum for maximum hydrolysis in the case of tea. After hydrolysis, the solution was neutralised, clarified and the reducing sugars were estimated by Lane and Eynon method. The total reducing sugars are expressed as glucose. For comparison, the maximum constituents extractable from tea were ascertained by analysing the brew obtained by refluxing at 98°C, 2.5 g. tea with 200 ml. water for 1 hour. Another series of comparative trials were run using water at room temperature (26°C) for different times namely 10 mts. ½ hr., 1 hr., 6 hrs., and 12 hrs. and a ratio of 1:100 (w/v).

The results are presented in Figures 7 (solids), 8 (tannins), 9 (caffeine), 10 (sugars), 11 (minerals) and 12 (colour).

The percentages of various constituents extracted from tea at different temperatures (Fig. 13 A & B) for different intervals of time (Fig. 14 A & B) with reference to the constituents extracted in 6 mts. normal brewing and 1 hour reflux brewing are given in Table V. The percentage of the various constituents extracted at different temperatures with reference to the total soluble solids in 10 minutes and 6 minutes brew are given in Table VI.

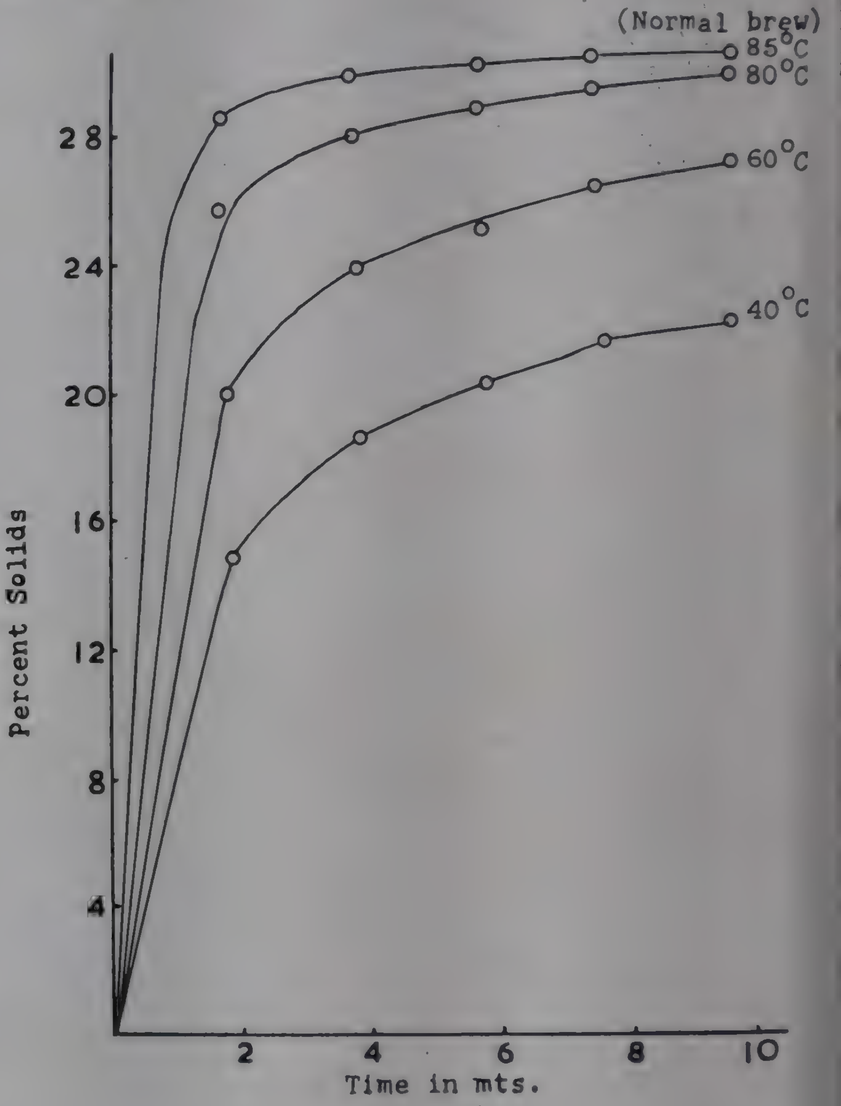

FIG. 7

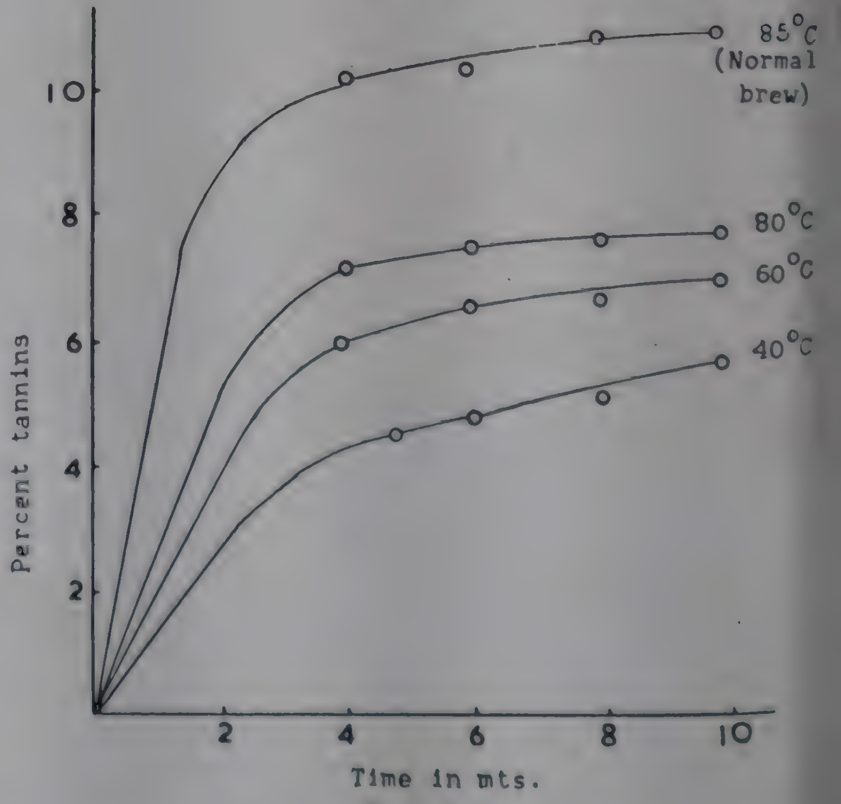

FIG. 8

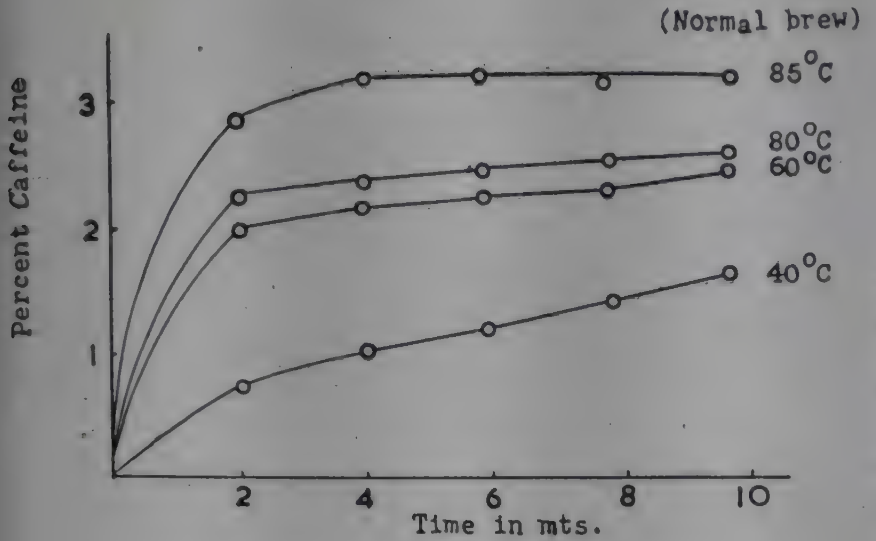

FIG. 9

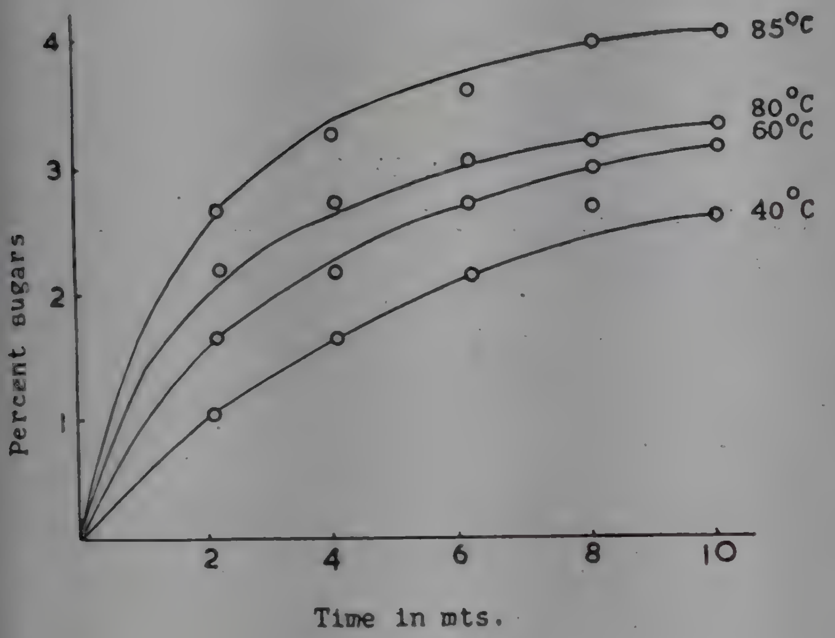

FIG. 10

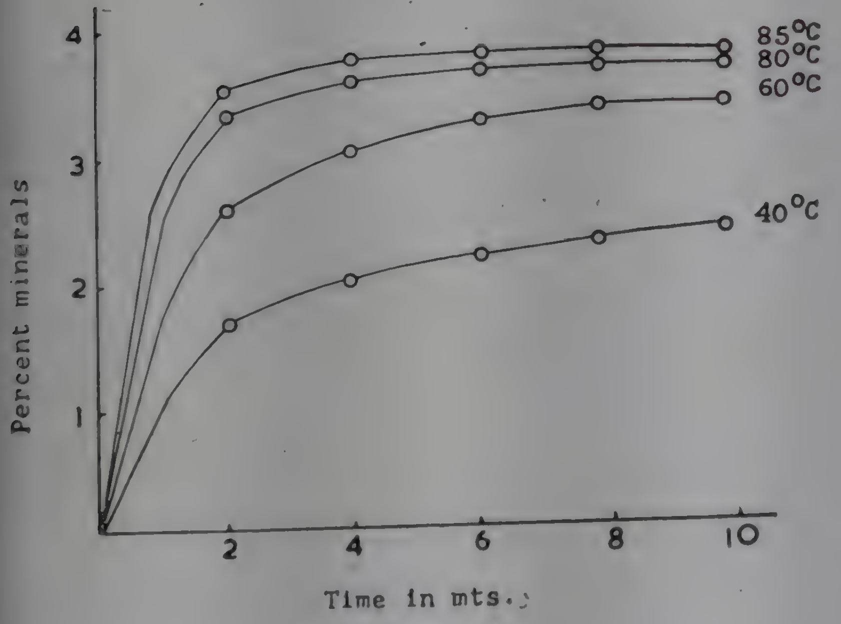

FIG. 11

(*d*) *Effect of pre-wetting and pre-warming on extraction:* It was reported earlier from this laboratory[9] that the extraction is improved by pre-wetting coffee powder before brewing. It was, therefore, of interest to find out the effect of pre-wetting on the brewing of tea.

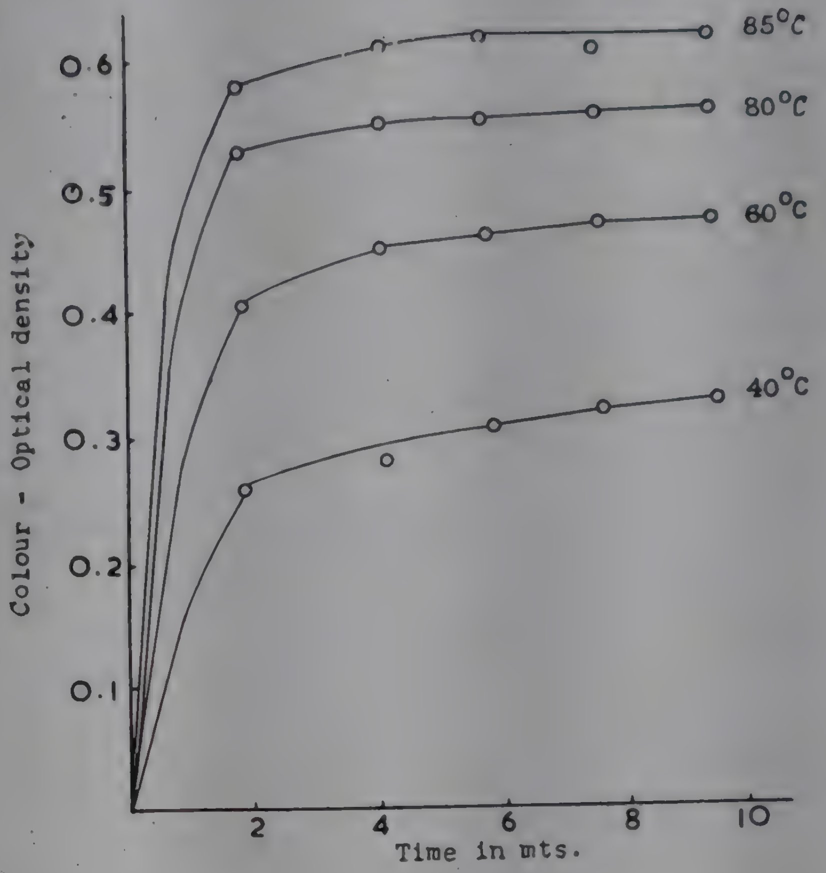

FIG. 12

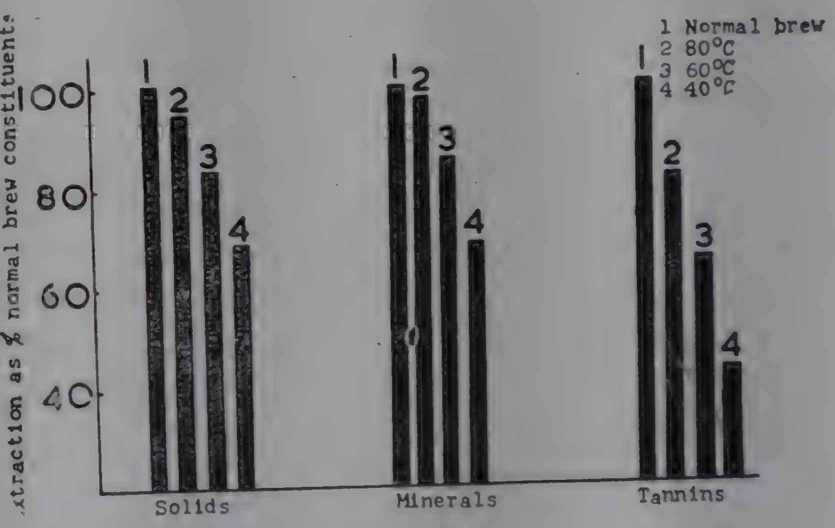

FIG. 13 A

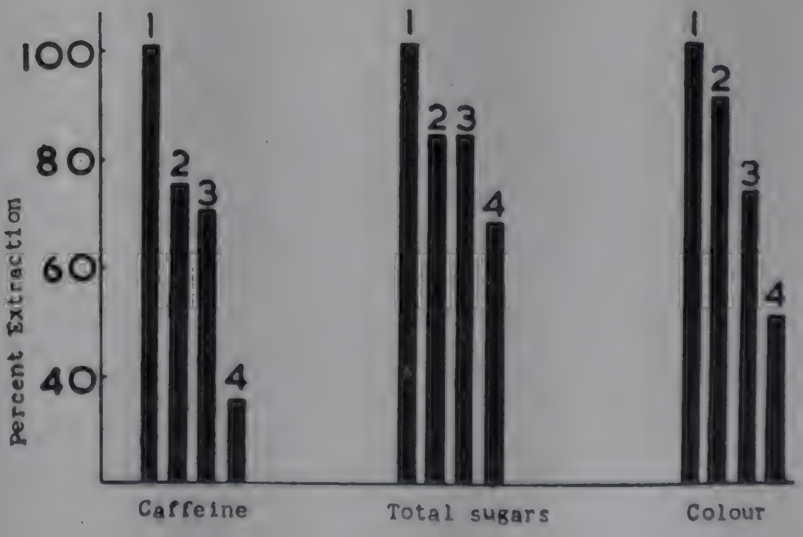

FIG. 13 B

TABLE IV. *Extraction rates of some constituents in different grades of tea as per cent of total solids*

Constituents	Time in minutes	Grade		
		Broken Pekoe	Broken Orange Pekoe	Dust
Total solids% (moisture free basis) ...	2	22.60	24.67	34.40
	4	25.95	28.54	34.73
	6	26.71	30.56	35.02
	8	28.00	31.14	35.30
	10	28.20	33.04	35.78
		as per cent total soluble solids		
Minerals ...	4	...	7	7
	6	...	8	9
	8	...	7	10
	10	...	8	10
Tannins ...	2	26	28	39
	4	30	30	40
	6	30	33	41
	8	32	34	41
	10	34	...	43
Caffeine ...	2	...	13	13
	4	12	13	12
	6	12	12	12
	8	13	12	12
	10	14	12	12
Non-caffeine nitrogen ...	2	2.0	2.9	2.8
	4	2.4	3.1	2.9
	6	2.7	3.2	3.1
	8	2.9	3.0	3.1

These conditions were found to be optimum for maximum hydrolysis in the case of tea. After hydrolysis, the solution was neutralised, clarified and the reducing sugars were estimated by Lane and Eynon method. The total reducing sugars are expressed as glucose. For comparison, the maximum constituents extractable from tea were ascertained by analysing the brew obtained by refluxing at 98°C, 2.5 g. tea with 200 ml. water for 1 hour. Another series of comparative trials were run using water at room temperature (26°C) for different times namely 10 mts. ½ hr., 1 hr., 6 hrs., and 12 hrs. and a ratio of 1:100 (w/v).

The results are presented in Figures 7 (solids), 8 (tannins), 9 (caffeine), 10 (sugars), 11 (minerals) and 12 (colour).

The percentages of various constituents extracted from tea at different temperatures (Fig. 13 A & B) for different intervals of time (Fig. 14 A & B) with reference to the constituents extracted in 6 mts. normal brewing and 1 hour reflux brewing are given in Table V. The percentage of the various constituents extracted at different temperatures with reference to the total soluble solids in 10 minutes and 6 minutes brew are given in Table VI.

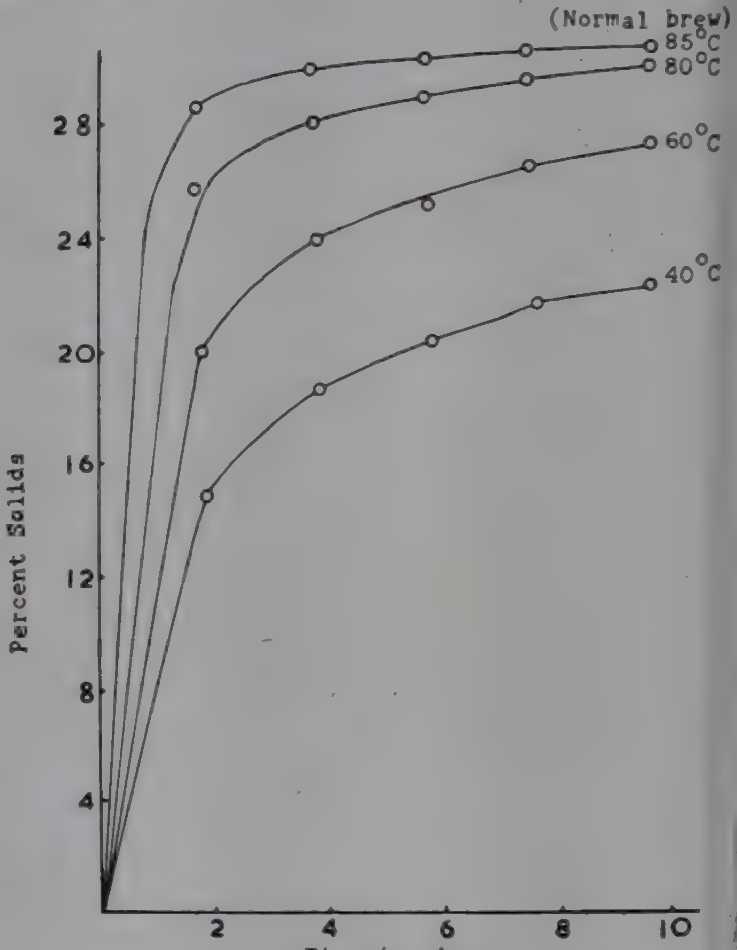

FIG. 7

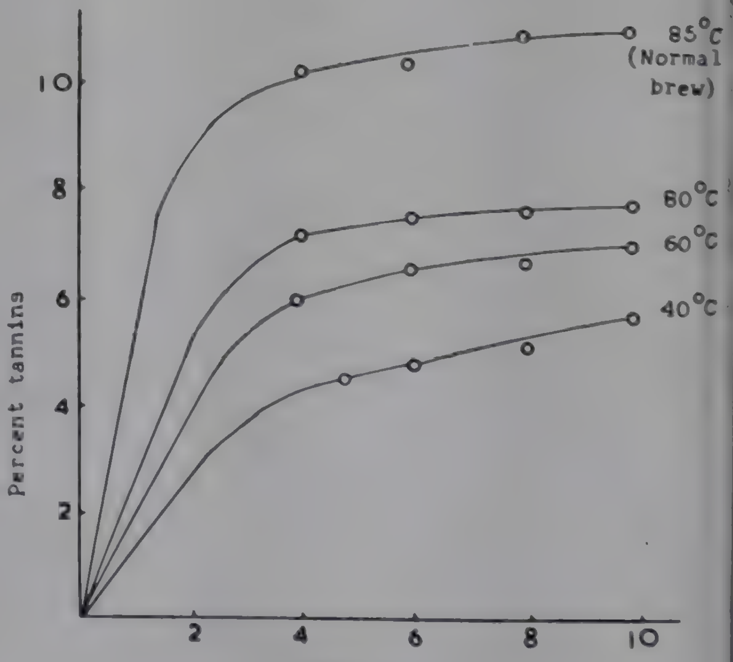

FIG. 8

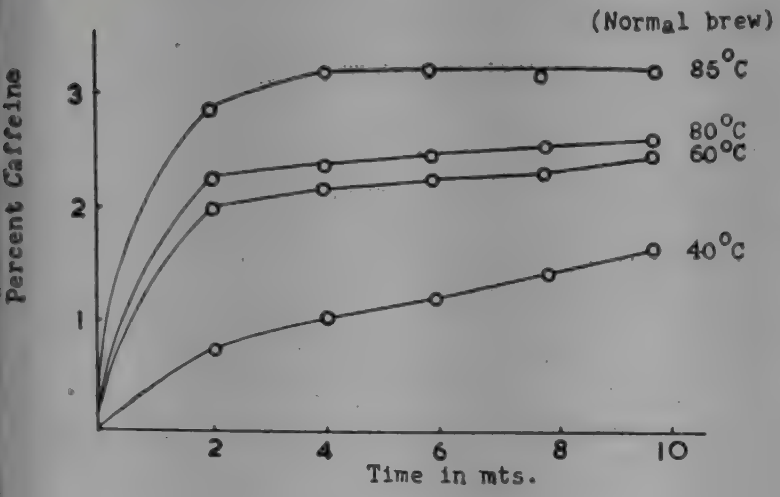

FIG. 9

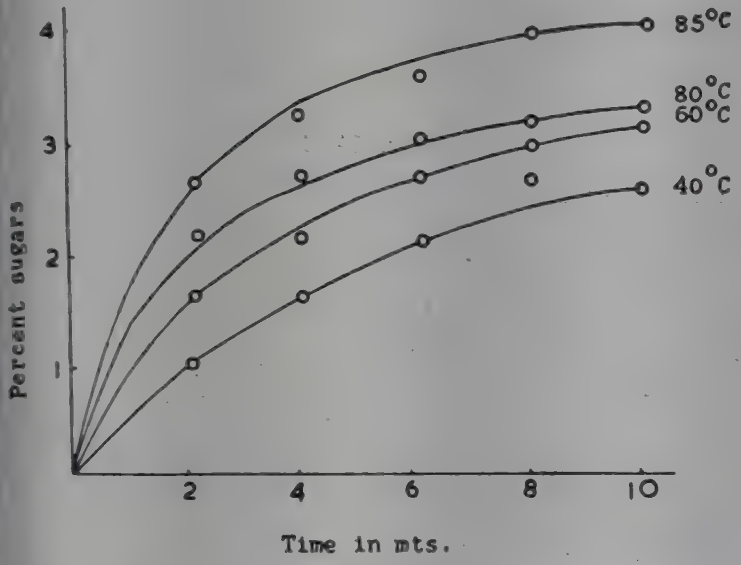

FIG. 10

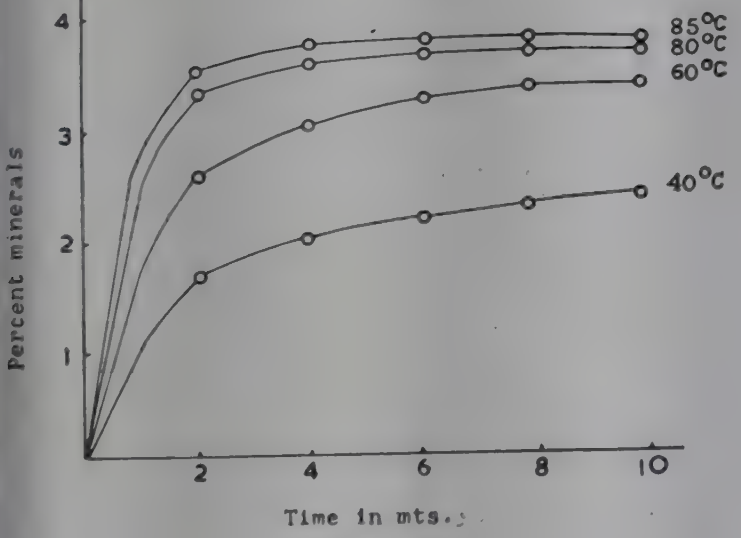

FIG. 11

(*d*) *Effect of pre-wetting and pre-warming on extraction:* It was reported earlier from this laboratory[9] that the extraction is improved by pre-wetting coffee powder before brewing. It was, therefore, of interest to find out the effect of pre-wetting on the brewing of tea.

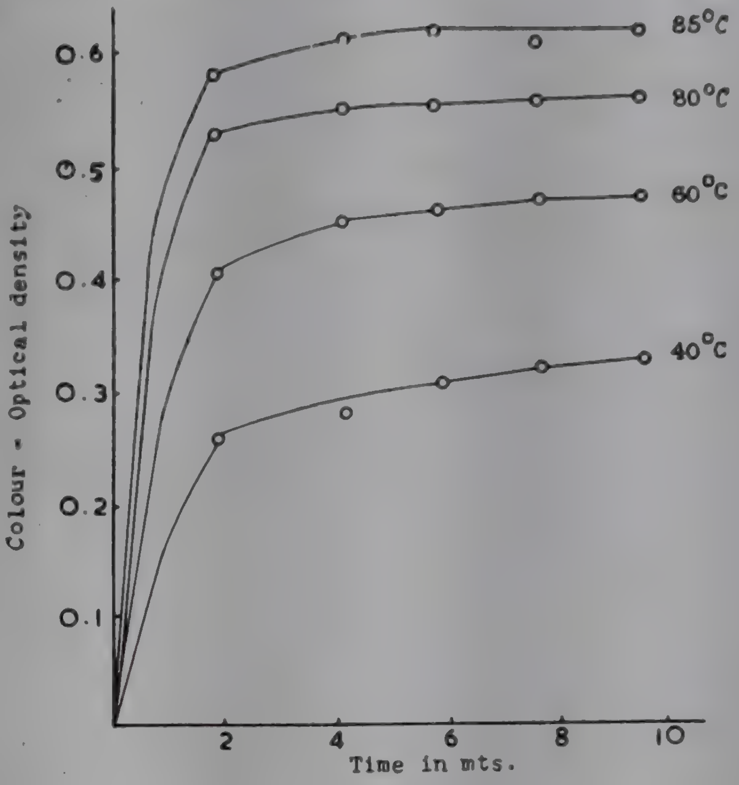

FIG. 12

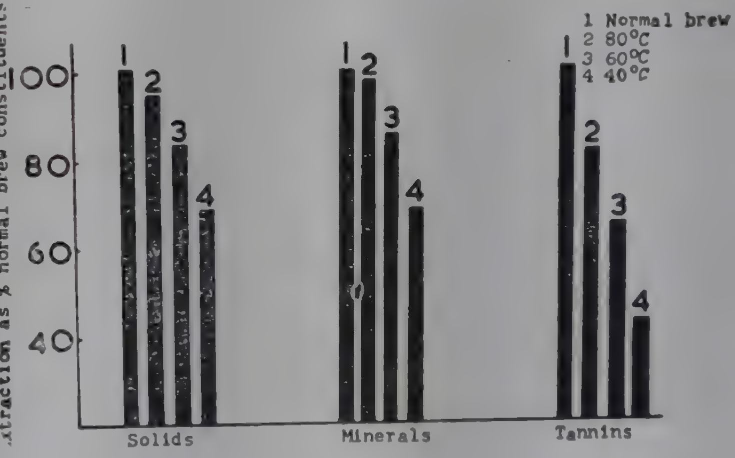

FIG. 13 A

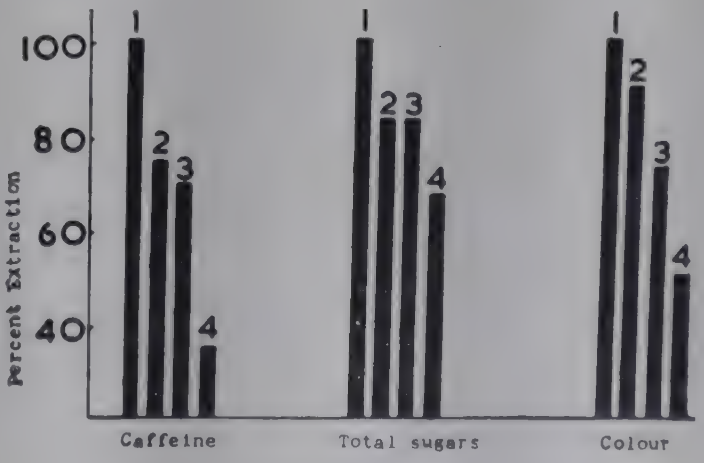

FIG. 13 B

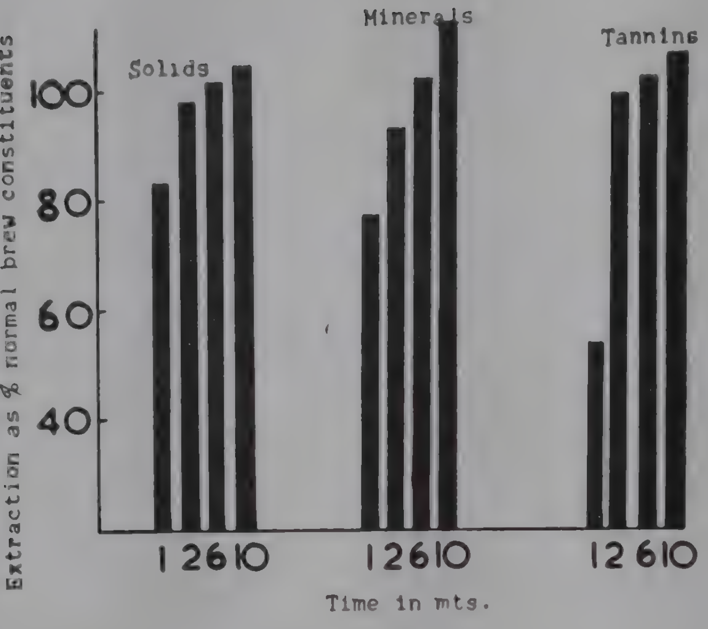

FIG. 14 A

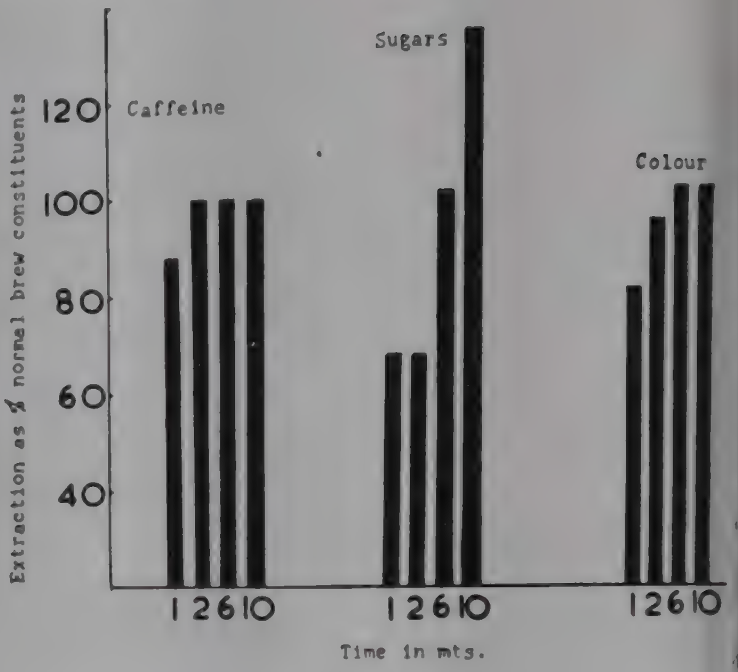

FIG. 14 B

TABLE V. *Extraction rates of tea at different temperatures with respect to normal and one hour reflux brew*
B.O.P. Grade

Temperature (0°C)			40°				60°				80°				Normal brewing 85°						26° (Room temperature)			
Time in mts.			4	6	8	10	4	6	8	10	4	6	8	10	1	2	4	6	8	10	10	½ hr.	1 hr.	[illegible]
			per cent				per cent				per cent				per cent						per cent			
Total solids	(*a*)	30.28	61	67	72	72	79	83	87	89	93	94	94	97	83	97	99	100	100	103	54	70	70	[illegible]
	(*b*)	39.47	47	52	55	55	55	63	67	68	71	72	72	74	64	74	76	77	77	79	41	54	53	[illegible]
Minerals (ash)	(*a*)	3.82	53	56	66	66	78	85	89	89	97	97	97	98	76	92	96	100	100	110	173	94	94	[illegible]
	(*b*)	4.20	48	51	60	60	71	77	81	81	89	89	89	89	67	83	87	91	91	100	66	85	84	[illegible]
Tannins	(*a*)	10.36	42	42	49	55	57	63	65	66	70	71	72	74	53	97	98	100	103	104	40	49	53	[illegible]
	(*b*)	15.42	28	28	33	37	38	42	44	44	47	48	48	50	35	66	67	67	69	70	27	33	35	[illegible]
Caffeine	(*a*)	3.22	28	35	44	49	65	70	75	75	72	75	79	79	88	100	100	100	100	100	35	38	39	[illegible]
	(*b*)	3.81	24	29	37	42	55	59	63	63	61	63	67	67	75	85	85	85	85	85	29	32	33	[illegible]
Total Sugars	(*a*)	3.24	50	67	83	83	67	83	83	100	83	83	100	100	67	67	100	100	133	133	50	50	50	[illegible]
	(*b*)	5.40	30	40	50	50	40	50	50	60	50	50	60	60	40	40	60	60	80	80	30	30	30	[illegible]
Colour (optical density)	(*a*)	0.62	46	50	52	52	69	73	76	76	86	90	90	90	80	94	100	100	100	100	29	42	41	[illegible]
(With oxalic acid 5 c.c. brew— 2 c.c. oxalic— 5 c.c. water)	(*b*)	0.96	30	32	34	34	44	47	50	50	55	57	57	57	52	61	65	65	65	65	19	27	27	[illegible]

(*a*) Normal brew. (*b*) 1 Hour reflux brew.

8.75 g. of tea was wetted with 15 ml. of hot water (70°C) and after 5 mts., boiling water (700 c.c.) was poured into the porcelain tea pot. The brew obtained after 6 minutes was analysed for total soluble solids using 100 ml. aliquots. Six extractions were carried out in every case.

Using the same pot as above, the brew wa prepared with and without pre-warming the po

TABLE VI. *Extraction of some constituents at different temperatures*

Time in minutes	Temperature in °C	% total solids	As per cent of total solids					Colour optical density		Colour index per gram tea
			Minerals	Tannins	Caffeine	Non-caffeine nitrogen	Total sugars	With oxalic acid	Without oxalic acid	
10	26	16.27	16.9	25.9	6.6	1.7	9.8	0.18	0.22	0.43
	40	21.67	11.7	26.2	7.3	2.7	12.5	0.32	0.43	0.77
	60	26.95	12.1	25.4	8.9	2.2	11.9	0.48	0.60	0.97
	80	29.16	11.6	26.3	8.7	2.5	11.1	0.56	0.73	1.35
	85 (normal)	31.01	13.5	35.0	10.4	2.4	13.9	0.62	0.76	1.49
6	40	20.4	10.5	21.4	5.5	2.5	10.6	0.31	0.42	0.74
	60	24.98	13.0	26.1	9.0	2.0	10.8	0.45	0.57	1.08
	80	28.54	13.0	25.7	8.4	2.2	9.5	0.56	0.72	1.34
	85 (normal)	30.28	12.6	34.2	10.6	1.9	10.7	0.62	0.76	1.49

TABLE VII. *Effect of pre-wetting and pre-warming on the efficiency of extraction (B.O.P. grade)*

	Treatment	Average value of* solids (g/100 cc)		Significance
A	Pre-wetting ...	0.343	± 0.004 (20 d.f.)	A∼B not significant
B	Pre-warming	0.333		A∼C not significant
C	Pre-warming and pre-wetting	0.347		B∼C significant at 5% level
D	No pre-warming or pre-wetting	0.305		A∼D B∼D C∼D highly significant

C.D. at 5% level 0.013.
C.D. at 1% level 0.018.
C.D. at 0.1% level 0.024.

* 6 trials.

TABLE VIII. *Effect of pre-wetting different grades of tea on the efficiency of extraction*

Grade	B.O.P.	Fannings (g./100 cc)	Dust
Pre-wetting ...	0.34	0.36	0.38
No pre-wetting ...	0.31	0.36	0.38

The pre-warming was done by rinsing the pot with boiling water immediately before brewing. These trials were repeated six times.

The combined effect of pre-wetting and pre-warming was also ascertained. The data are given in Table VII.

Effects of pre-wetting different grades of tea on the efficiency of extraction: Using different grades of tea like B.O.P., Fannings and Dust the effect of pre-wetting was ascertained as detailed above. The results are given in Table VIII.

TABLE IX. *Effect of brewing to different capacities in a tea pot*

Trials	Wt. of tea (g.)	Vol. of water (ml.)	Vol. of the brew (ml.)	% of solid
I	3.75	300	285	20.02
II	7.5	600	550	22.49
III	9.4	750	700	23.59
IV	11.3	900	845	28.33

Maximum capacity	900 ml.
Brewing time	6 mts.
Grade	B.O.P.

TABLE X. *Rate of cooling in containers made of different materials*

Time in mts.	Temperature in °C											
	Aluminium		Glass		Tinned brass		Stainless steel		Brass*		Porcelain	
	Pre-warming	No pre-warming	Pre-warming	No pre-warming	Pre-warming	No pre-warming	Pre-warming	No pre-warming	Pre-warming	No pre-warming	Pre-warming	No pre-warming
0	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0	97.0
½′	92.5	90.5	93.0	91.0	92.0	90.5	93.0	90.5	93.0	88.0	91.0	87.5
1′	92.0	89.0	92.0	90.5	91.0	89.5	92.5	90.0	92.0	87.0	89.5	85.5
2′	90.0	88.0	91.0	89.0	89.5	88.0	91.5	89.0	91.0	86.0	88.5	84.0
3′	89.0	87.0	90.0	88.0	88.5	87.0	90.5	88.0	90.0	85.5	87.0	83.5
4′	88.0	86.0	88.5	87.0	87.0	85.5	90.0	87.5	89.0	84.5	85.5	82.0
5′	87.0	85.0	88.0	86.0	86.5	84.5	89.0	86.5	88.0	83.5	84.0	80.5
6′	86.0	84.0	87.0	85.0	85.0	84.0	88.5	86.0	87.5	83.0	83.0	79.0
7′	85.0	83.0	86.0	84.0	84.0	82.0	88.0	85.5	86.5	82.0	82.0	78.0
8′	84.0	82.0	85.0	83.5	83.0	81.0	87.0	84.5	85.5	81.0	80.5	77.0
9′	83.0	81.5	84.0	82.5	82.0	80.0	86.5	84.0	84.5	80.0	79.0	76.0
10′	82.0	80.5	83.5	81.5	81.0	79.0	86.0	83.5	84.0	79.5	78.0	75.5

* Nickel plated outside and silvered inside.
Volume of water—500 ml; Room temperature 26°C.

(*e*) *The performance of the tea pot at different capacities:* The efficiency of extraction in a given porcelain pot when brewed to different capacities was ascertained by brewing tea with different volumes of water (300, 600, 750, and 900 ml.) and keeping the ratio of wt. of tea to volume of water constant at 1 to 80. The 6 mts. brew in each case was analysed for total solids. The temperature of water in the pot during extraction was also ascertained in each case. The trials were repeated thrice and typical results are given in Table IX and Fig. 15.

(*f*) *Rate of cooling in different containers:* Since temperature during brewing influences the extraction efficiency, it was considered desirable to study the rate of cooling with containers made of different materials like glass, porcelain, stainless steel, aluminium, tinned brass and brass (nickel plated outside and silvered inside). Since the volume of water used influences considerabl the rate of cooling the present data were collecte using the same volume of water namely 500 ml (Table X).

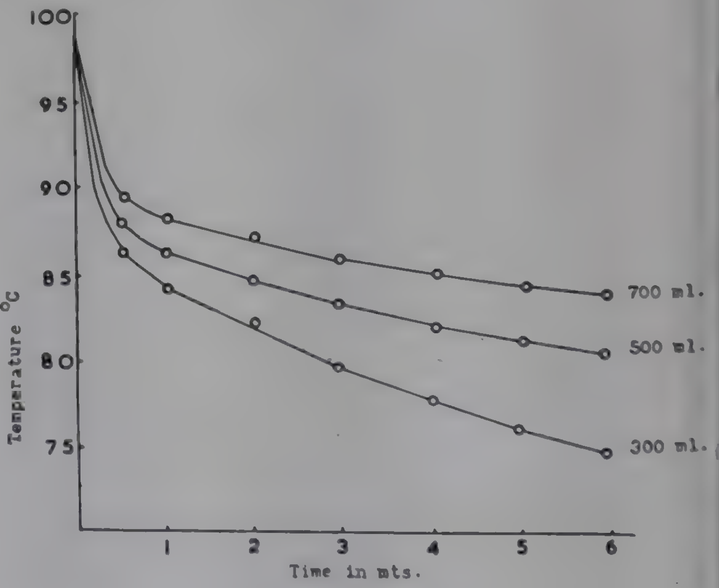

FIG. 15

TABLE XI. *Effect of minerals in water on cup test*

Ion	Concn. (p.p.m.)	Organoleptics			Threshold limit (p.p.m.)
		Colour	Taste	Aroma	
Bicarbonate as ($NaHCO_3$)	10	Normal	Improved		
	25	Normal			50
	50	Slightly dark	...		
	100	Darker	Affected (alkaline)	Affected	
Carbonate as (Na_2CO_3)	10				
	20	Darker			
	30	Darker			30
	50	Darker brew	Alkaline	Slightly affected	
	100		Alkaline		
Calcium as ($CaCl_2$)	50	Normal turbidity	Normal		
	100	Slight	Light		50
Magnesium as ($MgSO_4$)	100	No effect	Normal	Normal	
	200	...	...		200
	300	...	Slightly bitter		
Sulphate as (Na_2SO_4)	100	Normal	Normal	Normal	
	250	Normal	Not affected	Normal	
Chloride as (NaCl)	100	Normal	Improved slightly	Normal	
	300	Normal	Saltish	Normal	300

(*g*) *Effect of minerals in water versus organoleptic quality:* The taste thresholds of a number of inorganic ions found in water have been reported along with the thresholds in coffee brew[10]. The effect of some inorganic ions in water used during manufacture of black tea has also been reported[11]. While our investigations were nearing completion another report has appeared[12].

A series of solutions in distilled water varying in concentration with respect to a single component were prepared; sodium bicarbonate was used as a source of bicarbonate ions; sodium carbonate as carbonate ions; sodium chloride as chloride ions; magnesium sulphate as magnesium ions; calcium chloride as calcium ions and sodium sulphate as sulphate ions. The solutions containing different concentrations of the ions were used for brewing tea in the usual way. After repeated trials, the threshold limit for each ion was ascertained in each case and the average results are presented in Table XI.

Results and Discussion

(*a*) *Effect of ratio of tea to water:* The data in Fig. 1 show that as the ratio between weight of tea to volume of water increases upto 1:30, the percentage of soluble solids extracted from tea increases steeply and on further increase in this ratio, the increase in percentage of soluble solids extracted is gradual. The increase in solids beyond a ratio of 1:50 is not very significant. The ratio between the weight of tea to volume of water in normal brewing varies from 1:80 to 1:100. From the data in Table II it can be inferred that the brew obtained with a ratio of 1:30 is about 1.5 times as concentrated as that with 1:80 ratio. The concentration of the brew with ratios 1:10 and 1:20 is nearly 2 and 4.5 times as concentrated as that with 1:80 ratio.

(*b*) *Different grades vs. extraction of constituents:* The soluble solids, tannins and caffeine extracted by water increase for a given time in the following order—B.P., B.O.P., Fannings and

Dust (Table III). This is due to the reduction in particle size. The increase in solids for extraction time of 2 to 10 minutes with different grades of tea are as follows: *B.P.*—22.6 per cent to 28.2 per cent; *B.O.P.*—24.7 per cent to 33.0 per cent; *Dust*—34.4 per cent to 35.8 per cent (Table IV). The extraction is quick and maximum in the dust grade as one would expect. In the leaf grade like B.P. the extraction is slow. There is no significant difference in the extraction of caffeine and minerals, but in the case of tannins, the difference seems to be marked among the grades.

The increase in extraction in the case of dust grade seems to be accounted for essentially by the increase in the percentage of tannins extracted. The increase in tannins in a 6 minute brew between a Broken Pekoe grade and B.O.P. grade is 30 to 33 per cent for an increase of the total soluble solids of 26.7 per cent to 30.6 per cent. The increase in tannins for a 6 minutes brew between B.O.P. grade and dust is from 33 per cent to 41 per cent for a corresponding increase in solids from 30.6 to 35 per cent.

Trials conducted on the efficiency of extraction with different grades (B.P., B.O.P. and Dust) of tea for different intervals (6, 10 and 15 mts.) at constant temperature of 85°C showed that the solids obtained in normal brewing for the different grades are nearly the same as that for 6 mts. brewing time at 85°C. The solids obtained with B.P. and B.O.P. grades in 15 mts. were less as compared to that of the dust grade in 6 mts. or even in 2 mts. B.P. grade requires a contact time of about 10 mts. whereas B.O.P. and Dust require about 6 and 2 mts. respectively.

The rise in the extraction of different constituents is fairly steep during the first two to three minutes and with further increase in time the increase is gradual (Fig. 2-4). However in case of tannins and solids, extraction seems to increase with time in the case of *B.P.*, *B.O.P.* and *Fannings* grade. This difference in the extraction rate seems to be due to the difference in the particle size as shown by the extraction curves (Fig. 2) for the B.O.P. grade and the same grade after powdering to a fine Dust.

(*c*) *Effect of temperature on brewing:* In normal brewing where the temperature is above 80°C, the extraction of soluble solids, tannins, caffeine and colour is more as compared to the extraction at 80°C. Between 40°C and 80°C, the proportions of the various constituents extracted are nearly the same (Table VI).

The increase in solids in 1 hour reflux at boiling temperature (97°C) seems to be mainly accounted for by the increase in tannins and total sugars.

The extraction rate of various constituents at different temperatures is steep during the first 2 to 3 minutes. The differences in the extraction of solids and minerals at temperatures above 80°C is small as compared to the differences in the extraction between 40°C and 60°C or 60°C and 80°C. In the case of tannins, sugars and caffeine the differences in the extraction between 60°C and 80°C is small but the differences between 40°C and 60°C or 80°C and above are large; the effect being more pronounced in tannins between 80°C and 85°C.

In comparison with the normal brewing (mts.), the highest rate of extraction at 40°C i for total sugars (67 per cent), followed by ash (56 per cent), colour (50 per cent), tannin (42 pe cent) and caffeine (35 per cent). At 60°, th highest rate is for ash (85 per cent) followed by sugars (83 per cent), colour (73 per cent), caffein (70 per cent) and tannins (63 per cent). At 80°C the highest rate is for ash (97 per cent) followed by colour (90 per cent), sugars (83 per cent) caffeine (75 per cent) and tannins (71 per cent)

With reference to the extraction at 97°C fo 1 hour (the maximum extraction obtainable in tea the highest extraction in normal brewing is fo minerals (91 per cent) followed by caffeine (8 per cent), tannins (67 per cent) colour (65 per cent and sugars (60 per cent).

(*d*) *Effect of pre-wetting and pre-warming o brewing:* The effect of pre-wetting on increasin the efficiency of extraction was significant onl in the case of B.O.P. grade and not in fanning and dust grades (Table VII). The pre-wettin and pre-warming have similar influence on extrac tion and the combined effect of pre-warming an pre-wetting is the same as that of either pre-wettin or pre-warming. However, the differences wer highly significant between pre-wetting and n wetting or between pre-warming and no pre warming.

(*e*) *The performance of the tea pot:* One of the important factors which might influence the brewing of tea is the materials of construction of the brewing vessel. Brass, glass, stainless steel and porcelain are generally used. The difference in the rate of cooling or the total quantity of heat retained during brewing and the capacity to which brew is made have been shown to materially influence the extraction. Since porcelain is a common material used in the manufacture of tea pot, repeated trials were conducted under different capacities keeping the ratio between the weight of tea and volume of water constant. It was observed that as the volume of water used for brewing in the same pot increased, the percentage of solids in a known volume of the brew also increased thus showing that the efficiency of extraction is definitely improved by brewing to the full capacity of the pot. This is an important observation to be taken care of in the preparation of tea beverage (Table IX and Fig. 15). The differences in extraction seem to be due to the rapid cooling of water during brewing in the case of lower volumes of water as compared to the full volume of water used during brewing.

In 6 minutes brewing, the temperature in aluminium, glass, tinned brass, stainless steel, silvered brass (nickel plated outside) and porcelain came down from 97°C to 86°C, 87°C, 85°C, 88.5°C, 87.5°C and 83°C respectively when the containers were pre-warmed with boiling water. The corresponding temperatures without pre-warming were 1°C to 2°C lower in aluminium, glass and tinned brass whereas in stainless steel, brass and porcelain, the difference was 3°C to 4°C. In porcelain the differences between the temperature for any given time with and without pre-warming are more. Hence the pre-warming of porcelain is definitely advantageous for brewing.

(*f*) *Effect of minerals in water on organoleptic quality:* At concentrations of 10 to 25 p.p.m. of bicarbonate ions, a slight improvement in taste was observed; beyond 50 p.p.m., the colour of the brew became darker. With carbonates, the colour was affected beyond 20 p.p.m. calcium affects the extraction and causes turbidity. The extraction of colour is less beyond 50 p.p.m. and the taste is also affected. Magnesium ion does not seem to affect the extraction or taste in concentration upto 200 p.p.m. Sulphate and chloride ions in concentrations upto 300 p.p.m. do not affect the taste. Saltiness and bitterness are noticed in concentration above 300 p.p.m. Chloride ion at 100 p.p.m. (as sodium chloride) slightly improved the taste of brew.

The brew with distilled water was bland and was not considered satisfactory as compared to that made with water containing salts as in drinking water. It may therefore be worthwhile to use synthetic water containing different salts in optimum concentrations for brewing tea for quality evaluation.

Summary

(1) The rate of extraction of different constituents is influenced by the grade, the rate decreasing in the following order—Dust, Fannings, Broken Orange Pekoe and Broken Pekoe or leafy grade. The extraction in 2 mts. with Dust grade is more than that with B.P. and B.O.P. grade in 15 minutes.

(2) In normal brewing, the rise in the percentages of the various constituents extracted from different grades is rather steep in the first 3-4 minutes and beyond that time, the increase is gradual and small.

(3) The increase in extraction with Dust grade is essentially accounted for by the percentage increase in extraction of the tannins and sugars.

(4) The rate of extraction of solids, tannins, caffeine, sugars, minerals and colour, increases with increase of brewing temperature, the rate being faster during the first 2 minutes.

(5) As compared to the amount of constituents extracted in normal brewing (6 minutes), the percentages of solids, tannins and caffeine extracted during the same time at 40°C, 60°C and 80°C respectively are 67 per cent, 83 per cent and 94 per cent; 42 per cent, 63 per cent and 71 per cent; 35 per cent, 70 per cent and 75 per cent.

(6) With reference to the extraction at 97°C for 1 hour (the maximum extraction possible) the highest extraction attainable in 6 mts. during normal brewing is for minerals followed by caffeine, tannins, colour and sugars.

(7) The conditions influencing brewing apart from what has been detailed above are (*i*) Beyond a ratio of 1:35 between weight of tea and volume of water, the difference in the extraction is not very significant. (*ii*) The effect of pre-wetting

or pre-warming in increasing the extraction efficiency is nearly the same. The effect of pre-wetting and pre-warming is the same as that of either pre-wetting or pre-warming. The effect of pre-wetting is not significant in Fannings and Dust grade. (*iii*) It is always advisable to brew to the full capacity of the vessel to obtain efficient extraction. (*iv*) The material of construction of the brewing vessel influences the extraction due to the differences in heat retained and the rate of cooling. (*v*) For correct brewing, the following conditions seem to be optimum:

(*a*) a brewing temperature of not less than 85°C.

(*b*) a brewing time of 4 to 8 mts. depending on the grade.

(*c*) An extraction of not less than 25 per cent of the weight of tea.

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CHEMICAL COMPOSITION OF MARKET SAMPLES OF BLACK TEA

T. N. Ramakrishnan, S. N. Raghavendra Rao, E. Sankaran Nambudiri, S. Ramamani
C. P. Natarajan and D. S. Bhatia

(Central Food Technological Research Institute, Mysore)

Data on the chemical composition of seventy market samples of black tea are reported and the need for suitable grading based on cup test is stressed.

Detailed chemical analyses of garden samples of black tea manufactured in various regions of India have been presented in earlier publications from this laboratory[1, 2]. Since tea, as marketed, is invariably prepared by blending garden samples, it was considered necessary to analyse samples from different markets in the country. They were analysed by A.O.A.C. methods for moisture, total ash, water-insoluble ash, acid-insoluble ash, alkalinity of the ash, total nitrogen, petroleum ether extract, caffeine, tannins, sugars, crude fibre and total water extract. Cup test was also carried out on all the samples.

The results are summarised in Table I.

Table I. *Chemical composition of market samples of black tea*

Constituents	70 market samples			916 garden samples		
	Maximum	Average	Minimum	Maximum	Average	Minimum
Total ash ...	9.62	6.21	5.25	12.05	6.07	4.93
Water soluble ash (as per cent of total ash) ...	80.46	59.66	41.75	79.38	58.80	22.85
Alkalinity of soluble ash as K_2O per 100 g.	2.16	1.61	1.20	2.23	1.69	1.05
Acid insol ash %	2.26	0.45	0.13	5.78	0.42	0.01
Caffeine % ...	4.23	3.26	1.86	5.10	3.51	2.12
Crude fibre % ...	15.29	11.27	7.52	20.72	11.78	7.40
Tannins % ...	15.89	12.16	5.57	21.04	12.92	7.75
Total soluble solids % ...	45.72	41.08	32.54	47.50	40.28	32.12

Discussions

Almost all the market samples of black tea fall within the specifications laid down under PFA Act. The spread of values for various constituents and the number of samples which do not conform to a particular item are given in Table II. It is seen that the conclusions (Table III) drawn earlier[1, 2] for garden samples are also valid for market samples.

The cup test indicated that many of the samples were not so good in aroma and taste as compared to the garden samples tested earlier. The desirability of judging the quality of tea both by

Table II. *Spread of values for certain chemical constituents in market samples*

Constituent	Range of values	No. of samples	No. of samples not conforming to specification
Total ash %	5–7	65	1
	7.1–8	4	
	Above 8	1	
Water soluble ash as % of total ash	40–45	1	Nil
	45–50	3	
	Above 50	66	
Alkalinity as K_2O	1.2–1.30	2	4
	1.31–1.50	12	
	1.51–1.80	48	
	1.81–2.00	6	
	Above 2.00	2	
Acid insoluble ash %	Below 0.5	45	3
	0.51–1.0	22	
	Above 1.0	3	
Crude fibre %	Below 10	14	2
	10–12	33	
	12–15	21	
	Above 15	2	
Total soluble solids %	Below 35	3	3
	35–38	11	
	38–40	10	
	Above 40	46	

TABLE III. *Summary of the chemical data on Indian black tea*

Constituents	Values obtained for S.* Indian tea 524 samples			Values obtained for N.* Indian tea 384 samples			Values for Indian tea			Specification as per the Food Act	Recommended specification
	Maximum %	Average %	Minimum %	Maximum %	Average %	Minimum %	Maximum %	Average %	Minimum %		
Ash ...	12.05	6.02	4.23	7.70	6.15	4.93	12.06	6.07	4.23	5–8%	5–8%
Water soluble ash	72.97	57.72	22.82	79.38	60.00	44.27	79.38	58.68	22.85	Not less than 40%	Not less than 50%
Acid insoluble ash	5.78	0.42	.01	1.96	0.41	0.01	5.78	0.42	0.01	Not more than 1%	Not more than 1%
Alkalinity of ash as K_2O	2.61	1.70	1.05	2.23	1.69	1.11	2.23	1.70	1.05	1.3 to 2.0%	1.3 to 2.2%
Water extract ...	47.50	40.13	32.12	46.62	40.54	38.88	47.50	40.30	32.12	Not less than 35%	Not less than 35%
Crude fibre ...	16.58	11.75	7.48	20.72	11.33	7.62	20.72	11.78	7.40	Not more than 15%	Not more than 15%
Caffeine ...	5.10	3.30	2.12	5.52	3.80	2.47	5.10	3.51	2.12	...	Not less than 2.5%
Tannins ...	21.04	13.13	7.75	20.01	12.63	8.16	21.04	12.92	7.75	...	Not less than 9.0%

* N—North. * S—South.

the chemical as well as organoleptic tests have been stressed earlier and the views are further confirmed by the per cent evaluation of the market samples.

Summary

The analytical data on the composition of 70 samples of black tea obtained from various markets are presented. The early recommendations (Table III) based on the analyses of garden samples have been found to be applicable to market samples which are made by blending various garden samples.

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STUDIES TO IMPROVE THE KEEPING QUALITY OF FRIED SALTED BANANA CHIPS

N. L. Jain,[1] K. G. Nair, G. S. Siddappa and Girdhari Lal[2]
(Central Food Technological Research Institute, Mysore)

Production of fried salted banana chips is an mportant cottage industry in several of the banana growing regions of South India, particulary on the west coast. Large quantities of these are produced practically throughout the year by deep fat frying of unripe (raw) banana slices and salting them by dusting with powdered salt. The product thus prepared commercially is highly popular and finds a good market in these areas, but not in distant centres, mainly because it has a comparatively poor storage life and acquires rancid odour and disagreeable flavour rather quickly.

Oat flour has been reported to effectively protect nuts and potato chips against rancidity[1-5]. It has been used for dusting, for infusion into the fat or oil, and as a coating on the packaging material[2,3]. Magoffin and Betz[6] extended the storage life of potato chips and deep fat fried corn crisp by the use of antioxidants such as butylated hydroxy anisole, propyl gallate and citric acid in combination. Hall[7] and Sair and Hall[8] have reported increase in the shelf-life of nuts and potato chips by the use of salt coated with antioxidants. The present paper describes the results of studies undertaken to improve the keeping quality of deep fat fried and salted banana chips.

Material and Methods

Material: Fried and salted banana chips are prepared commercially in South India mostly from the unripe (raw) fruits of *Nendran* variety. Some of the other varieties find only a limited use for this purpose. The present series of experiments were carried out with raw bananas of *Nendran*, *Rasbale* and *Maduranga* varieties. In the case of the *Nendran* variety a comparative study was also made with ripe as well as unripe (raw) fruits. Fruits of this variety were obtained from Trichur within 24 hours after harvest, while those of *Rasabale* and *Maduranga* varieties were from the Institute garden and were used soon after harvest. The hydrogenated oil used had a peroxide value of 0.73 millimoles per litre and a free fatty acid value of zero.

Method of preparation: Ripe bananas were peeled by hand, while unripe fruits were first steamed for three minutes to facilitate the removal of the peel later with the help of a stainless steel knife. After peeling, the bananas were cut into slices 2/32″-3/32″ thick, using a stainless steel slicer. Chips were prepared by deep fat frying in hydrogenated vegetable oil.

Whenever the slices were given a preliminary soaking treatment, they were drained well and then wiped by spreading on a piece of thick absorbent cloth to remove any excess of surface water prior to frying. After frying, each lot was drained well and wiped gently with a piece of cloth to remove any excess of fat on the surface of the chips, before giving them any further treatment.

Analysis: Percentage fat in the product was estimated by extraction with chloroform, removal of the solvent by distillation and drying the fat to constant weight. Oxidative rancidity of the extracted fat was determined by the method of Paschke and Wheeler[9] and expressed as millimoles of peroxide per kg. fat.

Free fatty acid value of the extracted fat was determined by titrating the fat in neutral alcohol against N/10 NaOH, using phenolphthalein as indicator and expressed as mg. KOH required to neutralise the free fatty acids present in one gram of the fat.

Experimental

Preliminary experiments: The first set of preliminary experiments was carried out with *Nendran* variety. The data regarding the quality of chips under each treatment after nine weeks' storage at 37°C are shown in Table I. It will be seen that soaking of the raw banana slices for 10 minutes in a solution containing 5 per cent salt and 0.5 per cent potassium metabisulphite (KMS), as also the addition of an antioxidant (BHA) for fats and a synergist (citric acid) to the salt used for salting the chips by dusting after frying, improved considerably the storage behaviour of the chips. Preliminary soaking of the slices in salt solution containing KMS checked

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[1] At present Fruit Preservation Officer, I.A.R.I., New Delhi.

[2] Since retired from service.

TABLE I. *Effect of preliminary treatment of banana slices on the keeping quality of salted chips*

Treatment	Organoleptic quality of chips after 9 weeks' storage at 37°C
1. Slices soaked for 10 minutes in a solution of 5 per cent common salt and 0.5 per cent potassium metabisulphite (K.M.S.) drained and fried. Special salt mixture applied by dusting over the chips and shaking ...	Good Sample
2. Slices treated and fried as above, but salted with plain salt instead of the special salt mixture	Fairly good sample; flavour slightly rancid.
3. Slices fried 'as such' without any preliminary treatment and salted using special salt mixture as in the case of Sl. No. 1...	Colour and appearance good; but flavour rather rancid.
4. Slices fried as in Sl. No. 3 and salted with plain salt as in the case of Sl. No. 2	do
5. Slices 'as such', without any preliminary treatment, fried in oil with added 0.5 per cent powdered cloves (30 mesh fine) and salted with plain salt as in the case of Sl. No. 2 ...	Fairly good sample; flavour slightly rancid.

discolouration also in the interval between slicing and drying and improved the taste of the slices due to absorption of salt.

Coating of fried chips with salt and antioxidants: Fried chips, when dusted with finely powdered common salt at 6.7-10 per cent of their weight, took up 3.3-3.5 per cent of their weight of salt. For coating the fried chips with antioxidants or with salt alone, as the case may be, by dusting, salt equivalent to 6.67 per cent of their weight and double the quantity of antioxidants like butylated hydroxy anisole (BHA), nor-dihydro guaiaretic acid (NDGA), butylated hydroxytoluene (BHT), gallic acid, propyl gallate, etc., to be coated, were taken and were mixed well in a pestle and mortar. This mixture was then dusted over the chips which were shaken thoroughly (Table II). Nearly 50 per cent of the salt mixture taken was left un-used.

Further experiments to improve the shelf life of fried, salted banana chips: In a second set of experiments, prior to frying, the slices were given a soaking treatment in a solution containing 0.5 per cent citric acid in addition to the salt and KMS as detailed in the preliminary experiments. The chips were fried in oil containing different antioxidants (Table II) and dusted with salt as before. In this case also the salt take-up was approximately 3.3 per cent.

The fried and salted chips were packed in glass jars with metallic screw caps, the lids of which were dipped in wax for ensuring a good seal. They were wrapped in black paper as protection against light. The different lots were stored in an incubator at 37°C. One package under each treatment was removed at the end of 8, 12 and 28 weeks of storage and examined for organoleptic quality with a panel of carefully selected judges.

The percentage of fat, peroxide and acid values of the extracted fat were determined. Data obtained at the end of 28 weeks storage only are presented in Table II, since during the earlier storage tests the trends were practically similar in each case.

Chips from ripe fruits: In a third set of experiments, the banana chips were prepared from fully ripe and unripe (raw) *Nendran* banana fruits without any preliminary soaking treatment, etc. They were fried and salted by dusting with (*i*) common salt and (*ii*) with a special salt mixture consisting of 100 g. salt, 2 g. butylated hydroxy anisole (BHA) and 0.5 g. citric acid, all pulverized and mixed intimately. The chips from ripe fruits were rather dark brownish in colour and sweetish in taste, when compared to those prepared from the raw fruit, and deteriorated more rapidly in colour, appearance, etc., during storage.

Discussion

Slice thickness of 2/32″ to 3/32″ was found to be optimum for the preparation of fried and salted chips of good quality as the thicker slices had a tendency to burn and turn brownish before they were fried, as against the thinner slices yielding a bright coloured attractive product free from any of the above defects. The finished product (fried and salted) had a moisture content of 2.5-3.61 per cent (average 3.01 per cent) in the case of *Rasabale* variety and 2.62-4.43 per cent (average 3.50 per cent) in the case of *Maduranga* variety.

Treatment of the raw slices in a solution o

TABLE II. *Quality of the product after storage at 37°C under various treatments for 28 weeks (22 weeks in the case of sl. no. 15-18)*

Sl. no.	Antioxidants or synergists in the frying or dusting medium and details of packaging							Quality of the product after storage at 37°C			Organoleptic tests
									Analysis of extracted fat		
	BHA %	BHT %	NDGA %	Citric acid %	Propyl gallate %	Gallic acid %	Catacheu %	Fat extracted from chips %	Peroxide value (m.mole/kg.)	Acid value (mgm KOH) 1 g. of fat	
1	...	...	...	...	...	...	...	17.10	81.55	1.22	Highly repulsive flavour; very rancid.
2	0.01	...	...	0.004	0.003	...	...	19.14	4.37	0.86	Acceptable sample; free from rancid odour.
3	0.02	...	...	0.004	0.003	...	...	18.41	4.60	0.58	Good.
4	0.003	...	...	0.004	...	0.05	...	19.43	7.02	0.65	Fairly acceptable.
5	0.003	...	0.02	0.004	...	...	...	19.39	5.85	0.52	Not acceptable; slightly rancid.
6	0.01	0.02	...	0.004	...	...	...	20.67	3.70	0.81	Excellent.
7	...	...	0.02	0.004	...	...	0.1	19.23	4.76	1.12	Not acceptable; rather repulsive flavour and odour.
8	...	0.02	...	0.004	...	...	0.1	21.56	3.60	0.51	Fairly good.
9	Packed in sanitary cans under CO_2							21.87	5.76	0.49	Very good.
10	Packed in sanitary cans under nitrogen							22.18	2.90	0.50	Excellent.
11	...	...	...	...	...	...	...	17.46	10.52	1.58	Not acceptable; repulsive odour and flavour.
12	0.5	...	...	...	...	0.25	...	17.07	5.36	0.63	Fairly acceptable; free from rancid odour.
13	Oil left over from No. 12 plus 0.5% powdered cloves (30 mesh fine)							17.16	5.88	0.84	Acceptable; free from rancid odour.
14	Oil left over from No. 13 plus 1.0% cashew shell oil (extracted in the cold with ether)							16.05	21.71	3.17	Rather repulsive and rancid flavour.
15*	0.05	...	...	0.02	...	...	...	39.87	2.80	1.70	Not quite acceptable flavour; rather repulsive taste; fatty and soft texture.
16*	...	...	...	0.002	0.01	...	...	43.70	5.93	1.39	,,
17*	...	0.08	...	0.02	...	...	...	44.09	2.59	0.78	Quite a good sample; free from objectionable odour or flavour; taste rather fatty; texture soft.
18*	...	...	0.08	0.02	...	...	...	45.67	4.50	0.48	Fairly acceptable; free from rancid odour; but taste rather fatty; soft texture.

Note: In sl. nos. 12 and 15 to 18, the various antioxidants were added to the frying medium.
In sl. nos. 1-14, *Rasabale* variety of banana was used. In sl. nos. 15 to 18, *Maduranga* variety was used.

salt, KMS and citric acid, prior to frying, appeared to check to some extent the development of oxidative rancidity in the salted chips, besides protecting the raw slices against enzymatic browning during preparation for frying. These chips were found to keep quite well when packed in sanitary tin cans in an atmosphere of nitrogen. When coated with 0.01 per cent of their weight of BHA, 0.02 per cent BHT and 0.004 per cent citric acid in combination, applied as a dust intimately admixed with finely powdered salt, the fried chips, prepared as above, kept equally well under normal atmospheric conditions in hermetically sealed containers, when protected against the action of light. In tests carried upto 28 weeks storage at 37°C, (equivalent to one year at R.T.) samples under both the above treatments and packing conditions were found to retain pleasant taste and flavour and did not develop even a trace of oxidative rancidity. On the other hand, chips prepared exactly as above, but without a coating of antioxidants and citric acid, acquired a disagreeable taste and developed appreciable rancid odour. Treatments which gave good results next in order of merit in the above tests were (*i*) packing of the fried chips in an atmosphere of CO_2 in sanitary tins when not coated with antioxidants and (*ii*) a coating of 0.1 per cent catechu powder, 0.02 per cent BHT and 0.004 per cent citric acid in combination, applied as a dust with salt and packing in hermetically sealed containers, protected from light. Other treatments such as addition of the antioxidants, etc., to the frying medium did not yield quite satisfactory results.

Of the three varieties of banana used in these experiments, *Nendran* and *Rasabale* gave the best results, *Maduranga* having been found unsatisfactory as the fried chips of this variety had a rather fatty taste as compared to those from the other two. They contained on an average 41.33 per cent fat at the time of packing (39.89-45.77 per cent in different lots after 22 weeks storage at 37°C) in contrast to *Rasabale* which contained on an average 20.60 per cent at the time of packaging (16.5 to 22.28 per cent in different lots after 28 weeks storage at 37°C). Ripe bananas of *Nendran* variety did not yield fried chips of satisfactory quality. The sweetish taste was not quite acceptable and the unattracti dark brownish colour deteriorated furth during storage.

Summary and Conclusions

Deep fat fried and salted banana chips improved keeping quality have been successful prepared by soaking the raw banana slices f about 10 minutes in a solution containing 5 p cent salt, 0.5 per cent each of citric acid and KM followed by draining and wiping gently with clo to remove the excess surface water; frying hydrogenated oil, draining and wiping again remove excess fat from the chips, and final coating them with 3.33 per cent salt on the weig of chips, 0.01 per cent BHA, 0.002 per cent BH and 0.004 per cent citric acid applied by dusti as a mixture prepared by grinding the vario ingredients thoroughly and intimately in a pest and mortar. When packed in hermetical sealed containers and protected against light, t chips prepared as above did not show any deteri ration in quality during storage upto 28 weeks 37°C. Packing in an atmosphere of nitrog gave similar results even without the use of t fat antioxidants by coating the fried chi with salt only. The efficiency of the oth treatments which gave promising results has be discussed. Details of the method of applyi the mixture of salt and antioxidants have al been worked out. Slice thickness of 2/32"-3/3 was found to be the optimum for getting a fri product of satisfactory quality. Ripe banan did not yield chips of satisfactory quality.

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Technical Seminars

THE Seminar which is a regular scientific activity of the CFTRI provides an open forum for all scientific workers of the Institute in so far as one of them presents a paper on a problem on which he is engaged or reviews an aspect of Food Science and Technology, while others participate in the discussion and express their views on the subject matter of the paper. The visits of distinguished scientists and technologists are also made use of for arranging addresses to such gatherings. Summaries of the Seminars held during April—June, 1962 are given in this section.

(*IS*) 17

Production of blends resemb-
ng infant and weaning foods
om groundnut protein isolate,
M.R. Chandrasekhara, (*April* 26,
62).—Introducing the subject,
e speaker referred to the critical
sition of milk and milk products
India. Though the government
as keenly aware of this and was
ying to improve the dairy industry
all possible ways, it was difficult
meet the growing requirements
milk for the infant and children
opulation of the country in the
ar future. . The speaker then
entioned about the earlier work of
ubrahmanyan, Dean, Scrimshaw
nd others who had shown the
ossibilities of utilizing vegetable
roteins in the place of milk proteins
or feeding infants and children.
n most of these trials, the raw
aterial was the soya bean or milk
om it. But in the present investi-
ation, the starting material was the
rotein isolate obtained from the
tegrated process for the utilization
groundnut. He then mentioned
ome of the advantages of using the
rotein isolate in place of the cake
r the kernel *e.g.*, elimination of
soluble and indigestible carbohy-
rates; elimination of harmful sub-
tances like inhibitors etc., in the
aw material; elimination of paren-
al taste and flavour which may be
ery unpleasant to some palates and
he ease which the isolates would
rovide in terms of a comparatively
ure raw material for blending
ifferent formulations. Prelimi-
ary trials at the laboratory showed
hat the isolate when neutralised
nd spray dried had a poor keeping
uality. But this could be very
much improved by the incorpora-
ion of dextrimaltose. Regarding
he taste and flavour, the speaker said, that it could be reduced or modified, but still could not be entirely removed. He then described the method adopted for the preparation of two of the products namely the spray-dried protein food which had the composition of skim milk powder and spray-dried infant food which had a protein content of 26 per cent and fat 18 per cent. In both, the protein component was 2 parts from groundnut and one part from skim milk. Two trials on the production of these on a pilot plant scale had been carried out, one at Messrs Raptakos Brett in Bombay and the other at the Kamala Sugar Mills, Amaravatinagar. The salient points of difference between the two trials viz., use of dry protein and liquid dextrimaltose at Amaravatinagar as against the use of wet protein and dextrimaltose powder at Bombay, were explained.

Speaking next on the evaluation of the nutritive value of the two foods, Mr Chandrasekhara described the experiments carried out on them. In the protein efficiency ratios, he pointed out, though both the foods had a significantly lower PER at the conventional 10 per cent level as compared to that of milk protein, still at higher protein level i.e., at 15, 20 or 25 per cent, which are the usual levels at which these foods are fed to infants, the PER did not differ significantly from that of milk protein. This was probably due to the fact that quantity had made up for quality. When the infant food was used as the sole food for rats, it produced a better growth response over a period of eight weeks than milk food of similar composition. However, when the feed efficiency ratio was calculated the difference was not significant. Similarly the spray-dried protein food, when used as a supplement to poor rice diet, gave a growth response similar to that given by skim milk powder. He then presented the data on the body, liver and blood composition of these rats and pointed out that there were not any significant difference in the composition between the groups of rats on milk and protein food groups.

Summarising the data on animal experiments, the speaker said that (*i*) there were no significant differences in the PER of these food and control milk foods at levels of protein at which they were usually fed to infants and children. (*ii*) the infant food composition produced a similar growth response as milk food when given as the sole food for rats and (*iii*) the spray-dried protein food which had a composition similar to skim milk powder produced the same supplementary effect to poor rice diet as skim milk powder.

Concluding, the speaker remarked that the two spray-dried foods could be reconstituted easily in water to form a milk like emulsion, the powders had a good shelf life and could be used in place of milk powders. He pointed out that they contained only 1/4 to 1/3 part of milk powder and thus could extend the present resources of milk by three to four times.

In the discussion that followed, the following points were raised:

(*i*) In the evaluation of blends the proper expression of the nutritive value in terms of NDP cals which took into consideration both quality and quantity of protein, (*ii*) microbiological quality of the products, (*iii*) the development of off flavours during storage, (*iv*) contribution of other materials in the food towards the supplementary effect of these food for poor rice diet, (*v*) fortification of these blends with iron, (*vi*) origin of the milk powder used in these blends, (*vii*) addition of other flavours for the masking of groundnut flavour and (*viii*) whether the quality of a protein could always be corrected by quantity and whether PER measurement would be sufficient for the assessment of a protein.

Answering the questions, the speaker replied that it was true that the quality of a protein of a poor biological value could not be improved by quantity and the PER was only one of the methods of assessment of quality and should be substantiated by other methods of evaluation also. These foods had been bacteriologically tested and found to satisfy the standards for milk foods. They were fortified with iron. The storage tests had shown that they had a shelf life of seven months at 37°C when stored in nitrogen. In experiments where supplementary value of the food was being evaluated apart from the quantity of protein, other factors like the minerals and vitamin content also contributed to the growth of the animals. Addition of other flavours like vanilla etc., though they mask the inherent groundnut flavour, was not found suitable. Flavours like mango, cocoa or coconut were found to be quite suitable.

The President in his remarks, pointed out that the production of these foods in an easily reconstitutable form, fit for feeding infants and weaned children was unique and had not been tried out elsewhere. Regarding the methods of evaluation of protein, he remarked that there were several methods now available but each had its advantages and disadvantages. By and large, the method of PER where overall growth is measured had been found to be satisfactory. He thought that it might be possible and desirable to increase the nutritive value of these products to a level of milk or even higher if necessary by amino acid fortification. In conclusion he said that further work on these lines including infant feeding trials should be carried out.

S (*IS*) 18

✓**Preparation and properties of calcium caseinate,** by P. N. Achutamurthy, (*May* 3, 1962).—Introducing the subject, the speaker mentioned some of the important uses of calcium caseinate including its use in the treatment of hyperglycemia. He gave a brief account of the known brands of caseinates and described some general methods of preparation of calcium caseinate to the extent details were described in the literature which were few. He also presented some known facts about the dissolution of casein in alkalies. The preparatory steps described were: (*i*) washing of casein in hot water; (*ii*) dissolution of washed casein in ammonia; (*iii*) addition of calcium hydroxide in sucrose solution to the above dispersion; and (*iv*) drum-drying of the product.

The speaker said that it was necessary to wash the casein in hot water as otherwise the final product would retain the odour of original casein. He emphasised the necessity of initially dispersing casein in ammonia before the addition of calcium. The best way of bringing casein into homogeneous solution in ammonia would be to homogenise the washed casein with water and add the slurry to ammonia followed by occasional mixing.

The effect of addition of calcium oxide in excess and calcium oxide at 1 per cent level and ammonia, on the formation of dispersible calcium caseinate was then discussed. Pointing out the inherent defects in each of these methods, the speaker said that the optimum condition for the formation of calcium caseinate was the addition of calcium hydroxide in sucrose at 1 per cent level of calcium to casein previously dispersed in ammonia.

As regards drying of the product, he said that both vacuum shelf drying and freeze drying failed to give a dispersible product, while there was some difficulty in spray drying even though it did give a dispersible product. Drum drying gave the best results.

The possibility of obtaining edible dispersible calcium caseinate starting from a poor quality of casein was also mentioned. The speaker said that the product, however, had a slight colour. Some alternative methods of preparation were also described.

The novel feature of the whole process lay in the use of calcium hydroxide in sucrose solution in the place of aqueous calcium hydroxide, making use of the well known property of the high solubility of calcium hydroxide in sucrose solutions. Describing the detailed procedure for preparing the reagent (calcium saccharate), the speaker said that solutions containing over 9 per cent of calcium hydroxide (≡ 5 per cent Ca) could be prepared and that the reagent preserved its alkalinity for over a period of one month.

Then the details of methods of processing as finally evolved were touched upon. The average yield was 90 per cent. The product, a light white fluffy powder, was found to be dispersible in water to the extent of 10 per cent giving in solution a pH of 5.8. The solution was quite stable for 24 hours. Evidence for the absence of ionic calcium was presented. Papain coagulated the protein from solution with simultaneous release of the bound calcium. Inorganic phosphate and free reducing sugars were absent in the product, which was dispersible in solutions of ammonium citrate and ammonium phosphate but not in magnesium chloride. Boiling did not destroy the dispersibility, while auto-claving did. Referring to the growth studies with rats, the speaker pointed out that the method of processing did not have any adverse effect on the nutritive value of the product. He mentioned that treatment of *Kwashiorkor* cases was under progress and results in that line of study were quite encouraging.

Before concluding, the speaker presented some information relating to the nature of calcium as present in milk and also the nature of calcium binding to casein.

During the discussion the points raised related to microbial load of the product as well as of the starting materials, use of skim milk as a starting material, ash content of casein and proximate composition of the product. Suggestion was made about the use of phosphoprotein phosphatase for determining the nature of binding between calcium and casein.

In the course of replying, Dr M. Srinivasan said that this would be done and drew particular attention to the finding that calcium treated proteins were completely odourless at least immediately after drum drying, and therefore, the use of calcium hydroxide in sucrose as a general reagent for processing proteins deserved to be studied more.

Winding up the discussion the president said that it was a completely worked out method for subsequent exploitation. He indicated the desirability of conducting large scale trials in collaboration with a producer of casein or skim milk powder. Concluding, he suggested that spray drying could be adopted with suitable modifications in the procedure.

S (*IS*) 19

Influence of dietary proteins and sulfa drugs on the ascorbic acid status of the rat, by N. Chandrasekhara (*May* 30, 1962).—The speaker traced the origin of the investigation to the observation that the seeds of *Sesbania grandiflora* containing a very high percentage of protein (70 per cent) and almost no free carbohydrate, generated on germination more ascorbic acid than any other leguminous seed. This prompted the question whether dietary protein content would influence the vitamin C status of the rat. He then described the details regarding animals used in the experiments, collection of urine, preparation of tissue, methods of estimation and the procedure used for identification of ascorbic acid.

Presenting the results, the speaker said that as the level of casein in the diet increased, the urinary and total liver ascorbic acid increased almost proportionately. This result was further substantiated by sequentially feeding diets containing increasing levels of casein. Total inanition for 7 days neither decreased the urinary excretion nor the liver level of the vitamin unlike feeding a protein-free diet. When a 10 per cent gelatin diet was fed, the excretion and the liver level of the vitamin decreased. Increasing the gelatin content to 20 per cent decreased the ascorbic acid excretion further. However, when the 10 per cent gelatin diet was supplemented with essential amino acids to bring it to a level with the 10 per cent casein diet, the urinary and liver levels of the vitamin were restored.

Another facet of the problem the speaker discussed was the probable role of intestinal microflora in the biosynthesis of ascorbic acid. He said that inclusion of sulfaguanidine or sulfasuccidine at 2 per cent level caused a depression in the urinary and liver levels of the vitamin on the protein-free and 10 per cent casein diets, while such an effect was not observed on the 50 per cent casein diet. Inclusion in the diet of 10 per cent lactose which is known to promote the proliferation of micro-organisms served to abolish the effect of the sulfa drug. But increasing the level of sulfaguanidine to 4 per cent reversed this. It was also stated that lactose by itself did not seem to augment ascorbic acid excretion as indicated by its inclusion in the 10 per cent gelatin diet or in a 30 per cent casein diet. Vitamin B_{12} injections at 5 μg/rat/dav for 7 days did not restore the ascorbic acid excretion of rats fed a 10 per cent casein diet containing lactose and 4 per cent sulfaguanidine (6 weeks).

Finally he said that the depressant action of 2 per cent sulfasuccidine in a 10 per cent casein diet was due not to the lowering of the concentration of 1-gulono-lactone oxidase, the enzyme catalysing the conversion of 1-gulono-lactose to 2-ketogulonolactone, in the sulfa treated animals. He concluded by saying that: (*i*) the other enzymes involved in ascorbic acid biosynthesis had also to be looked into; (*ii*) the effect of the high protein diet still needed an explanation; and (*iii*) that the role of microflora, if any, required further elucidation.

Supplementing the speaker's presentation, Shri M. V. L. Rao explained that the experiments bearing on the protective effect of proteins on the adverse influence of sulfadrugs on urinary and tissue ascorbic acid stemmed from the reported findings of Schwartz, Williams and co-workers that both aminopterin and sulfasuccidine considerably depressed the liver ascorbic acid levels which were not restored even after adequate supplementation with folic acid. Their experiments were primarily directed towards elucidating the interrelation between folic acid and vitamin C. The noteworthy additional finding that has emerged in the present studies is the protective action of high levels of dietary protein on the depressant action of sulfaguanidine or sulfasuccidine on urinary and liver ascorbic acid in rats receiving diets adequate with respect to folic acid. Although the influence of dietary protein levels as such may be readily understood in terms of their possible influence on liver enzyme systems concerned with ascorbic acid biogenesis, their protective action against sulfa drugs would have to take into consideration, other possible influences, such as, on the intestinal microflora, or on the intestine *per se*. Morphological changes in the intestine are reported to be induced by feeding sulfa drugs.

The observed influence of lactose supplements in counteracting the influence of sulfa drugs would seem to provide supporting evidence for the possible involvement of the microflora in the synthesis of ascorbic acid in the rat either by providing preformed vitamin C or its important precursors. At the same time, the possible contribution of the galactose component of the lactose to increased ascorbic acid synthesis has also to be taken into consideration, especially because, it is reported to be a better precursor for ascorbic acid than even glucose. The observation of Reyniers that the germ-free suckling rat requires a dietary source of ascorbic acid lends additional support to the indications obtained in the present study that intestinal micro-organisms may be involved in the elaboration of vitamin C in the rat to some extent.

Speaking next, Dr M. Srinivasan drew pointed attention to the frequently reported clinical observations which indicated that under various conditions, groups of people, adults as well as children, receiving diets low in ascorbic acid were not only free from overt symptoms of scurvy but also excreted fair amounts of the vitamin in the urine. In some instances the blood levels were also satisfactory, approaching those of the saturated subjects. He particularly cited Walker's extensive report on the clinical survey of the Bantu children. He then referred to the recent report by Baker and co-workers on the conversion of orally ingested glucuronolactone into ascorbic acid in human subjects. He said this was a very exciting finding which deserved careful attention and critical examination. All these findings taken together suggest the possibility of a certain measure of endogenous provision of vitamin C either through microbial or other sources. Dietary protein may directly or indirectly affect these processes and thus influence the ascorbic acid requirements of man which as laid down by the various authorities has fluctuated from 70 to 30 and even 10 mg.

In the lively discussion that ensued, several questions were raised relating to the adequacy of the method employed for estimating microgram quantities of vitamin C, the status of dehydroascorbic acid in tissues, the high dosage of sulfa drug employed, the influence of protein diets on the vitamin requirements of humans and the undesirability of reducing the intake of vitamin below 30-40 mg. per day, the ascorbic acid content of the tissues of germ-free rats, the increased serum vitamin C level after antibiotic therapy in certain cases of wound healing, the influence of poorly digested proteins in the diet which promote poliferation of anerobes in the intestine and the use of sorbose in the diet which is known to be converted into certain ascorbic acid precursors by some microorganisms (eg. *A. suboxydans*).

In answering the questions raised, the authors made the following points:

The Roe and Keuther method of estimation employed in the above studies for the determination of urinary and tissue ascorbic acid is capable of measuring microgram quantities of the vitamin and its oxidation products up to the diketogulonic acid, which retain the 6-carbon chain intact.

It is currently held that dehydroascorbic acid being non-ionic in character diffuses more readily into the cell and is the preferred transport form of the vitamin.

The doses of sulfa drug are those normally employed in nutritional studies. Experiments have been carried out with much higher doses of the sulfa drugs by other workers.

Details concerning the tissue levels and excretion of vitamin C in germ-free rats are not available.

Experiments are now in progress to determine any possible direct correlation between the intestinal microflora (coliforms, anaerobes and other types) with the urinary excretion and tissue levels of the vitamin in rats maintained on diets containing different levels of protein and sulfa drugs.

Although the absence of the pathoses of scurvy in humans is explicable in terms of physiological adaptation, the divergence between intake and excretion and blood levels observed, necessarily points to the possibility of an extra-dietary source of a certain amount of ascorbic acid even in man.

In his concluding remarks, the President mentioned that in explaining the effect of sulfa drugs and dietary proteins on the ascorbic acid status of the rat, in addition to what the authors had mentioned, it would be necessary to bear in mind the possible metabolic and other effects of high dietary protein levels which might tantamount to a stress condition and the extra synthesis on high-protein diets might represent an adaptation on the part of the organism to increased requirements. It is also likely that high protein diets may serve to stabilise the vitamin in the tissue through the provision of increased amounts of -SH groups.

S (*IS*) 20

Studies on enriched tapioca macaroni products, by G. S. Bains, N. Gopalakrishna Rao and S. Venkat Rao (*June* 11, 1962).—Reviewing the investigations on tapioca macaroni leading to its production in the pilot plant which was set up at the Institute in 1956 and the work in progress in related directions in Continental industrial laboratories, Shri Bains said that the concept of composite blends has been further developed to include enriched forms of tapioca macaroni containing 18-20 per cent protein. Products obtained from four different blends, *viz*., A (tapioca flour 50, peanut flour 25, semolina 22.5 and casein 2.5 parts), B (tapioca flour 47.5, peanut flour 30 and semolina 22.5 parts), C (tapioca flour 35, peanut flour 25, semolina 30 and non-fat milk solids 10 parts) and D (tapioca flour 35, peanut flour 25, semolina 25 and chickpea flour 15 parts), each fortified with vitamin A—7.5 lakh I.U., vitamin D (calciferol)—0.5 lakh I.U., thiamin hydrochloride—125 mg., riboflavin—250 mg., calcium pantothenate—250 mg., calcium carbonate 0.5 lb. and tricalcium phosphate 0.5 lb. per 100 lb. batch, were studied in detail. Peanut flour was the main source of protein in the blends and ingredients like casein, non-fat milk solids and chickpea flour were used to improve the quality of protein in the products.

Boiling water was used to obtain a fairly stiff dough which was extruded in the ATA press in different shapes, passed through a pre-drier, steamed, and dried in the TTHA drier at 55°C, to a moisture content of 8-9 per cent.

Generally, the products are quite palatable, cook to a soft texture in 4-5 minutes and can be used in a variety of ways not only by children but also by other age groups.

Results showing the composition and nutritive value of the products were then presented. It was stated that the processing loss of vitamin A ranged from 32 to 33 per cent, of thiamine and riboflavin from 7 to 10 and 1 to 8 per cent respectively. The PER of processed products A, B, C and D were: 1.73, 1.47, 2.08 and 1.92 respectively, the corresponding values for unprocessed blends being 2.02, 1.74, 2.42 and 2.15. The products, when fed as the sole food to albino rats, produced good growth. Significantly higher gains in weight were shown by the animals fed product A, as compared with a proprietary cereal food. The replacement value of product A to the milk and rice components in the pattern of diet consumed by local children was studied by feeding such diets to young albino rats for 8 weeks. The results showed that a considerable portion of milk in the diet could be replaced by enriched tapioca macaroni.

The authors envisaged further improvement in the palatability and nutritive value of the products.

Dr T. R. Doraiswamy presented the results of human feeding tests carried out at Ramanagaram and at Mysore. At Ramanagaram, weaned infants and children (8-36 months old) were fed 2 oz. supplements of the products *i.e.*, blends A and D for six months while at Mysore, school children aged 6-11 years were fed for four months, a daily 4 oz. supplement of product D. The products were found acceptable to children at both the centres. The mean increases in height, weight and haemoglobin level of children in the experimental groups were significantly higher than those of the control group.

Dr D. S. Bhatia traced briefly the history of the project and narrated certain events which brought about the change in terminology from 'Synthetic Rice' to 'Tapioca Macaroni'. He stated that the studies under reference were an extension of previous work on tapioca macaroni. He drew attention to the fact that this mode of processing offers possibilities of developing a variety of products 'tailor-made' to suit specific requirements. He was of the opinion that, to popularise such products, it would be necessary to approach first that section of population who have the easy means to buy the product and to prepare it in a variety of ways for consumption. He further expressed the view that it would be necessary to solicit government support to sponsor the production of such products and, if necessary, even to subsidise the price so that these could be made available to a much larger section of people. He stressed the necessity of resuming the extension work with enthusiasm to promote these products and mentioned that the material required for the purpose would be made available inasmuch quantity as may be required. He thought that the Institute could claim justifiably the credit for having introduced the macaroni industry in the country. Though only Wheat macaroni was being produced at present, he was hopeful that the production of modified formulations would be taken up in due course.

In the discussion the questions raised related to: why the Industry had not yet taken the process for large-scale utilization; if products of that type were generally to be preferred by sophisticated people, they would also be the ones to object or not take kindly to the inclusion of tapioca flour in them.

In his presidential remarks, Dr A. Sreenivasan congratulated the speakers on the way the introduced, various phases of the subject were, and dealt with, thus indicating a fine team spirit. Posing the question, what next?, he said that it was basically incorrect to approach the problem of popularising the product in terms of stratified layers of society. Any programme relating to extended utilization of the macaroni products should have, in its view, the masses and strive towards mass-appeal, though a beginning might be made with the so called sophisticated section. He said that it would also be incorrect to compare these specially processed food products, which are high in protein and other nutrients, with basic foods with respect to both cost and acceptability, and, if proper extension work was undertaken even the low-income group people would certainly take to them. 'What is needed now', he added 'is a correct type of approach in terms of market research, extension, proper education of the masses and the like. It is upto us to demonstrate that the product could be used in a variety of ways and made available at reasonably low prices'. He indicated that the Institute might take some concrete steps in those directions.

As regards the products, he said, as already pointed out by the speakers, it was desirable to take adequate precautions to prevent the losses in nutrients during processing to develop products which need not necessarily involve use of paste-goods machinery and to improve on their nutritional qualities by the addition of extra amounts of lysine and methionine.

S (*IS*) 21

✓ **Some technological aspects of manufacture and storage of guava pectin,** by K. K. Mookerji (*June* 10, 1962).—The speaker said that the present investigations were taken up (*i*) to standardise the method for efficient recovery of pectin from guava; (*ii*) to study the chemical constituents and quality of pectin; (*iii*) to determine optimum harvest time when guavas were at their best with respect to quality and quantity of pectin; (*iv*) to determine the optimum storage period of fresh guava from the view point of pectin recovery; (*v*) to determine the best way of preservation of guava for subsequent recovery of pectin during off-season and (*vi*) to study the storage behaviour of liquid and powder pectin.

Employing paper partition chromatographic technique, the optimum conditions of enzymatic and acid hydrolysis of pectin and the qualitative and quantitative aspects of the chemical constituents of guava pectin were studied. Guava pectin was found to comprise d-galacturonic acid 72 per cent, d-galactose 12 per cent and 1-arabinose 4.4 per cent. However, it did not contain glucose as reported by Savur.

Of the various concentrations of HCl and citric acid studied, 0.75 per cent (0.117N) concentration of citric acid gave maximum yield of good quality pectin. The corresponding 0.75 per cent concentration of HCl (0.085N) also gave almost the same yield of pectin, but of slightly lower quality.

Maximum yield of pectin from guava was obtained by employing fruit—water ratio of 1:2, with double extraction for 60 minutes each.

The speaker said that the different components of guava fruit namely peel, flesh and core contained 10.08, 3.8 and 3.2 per cent pectin respectively (on moisture free basis). However, on the whole fruit basis, about 50 per cent of the total pectin was present in the flesh.

Of the four varieties, *viz.*, *Allahabad*, *Banaras*, *Safeda* and *Seedless* obtained from the CFTRI orchards, Banaras variety contained maximum pectin. The quality of the pectin of all the four varieties was more or less the same.

Guava fruit exhibited three stages of maturity under the climatic conditions of Mysore, *viz.*, (1) upto the age of about 30 days when development was very slow, (2) the age between 30 and 75 days, when the development was very rapid and (3) after 75 days when the fruit started over maturing, undergoing losses in many chemical components, one of which being the acid soluble pectin, the most important fraction of total pectins. Hence for efficient recovery of pectin, guava fruit should be picked up at the optimum age *viz.*, about 75 days after setting of the fruit.

Fully developed green fruits could be kept for 4 weeks at 47-50° F (RH 85-90 per cent) but with only slight changes in pectic substances.

Addition of 1000 p.p.m. SO_2 was found to be the best method of preserving guava pulp with the least deleterious effect on the stability and recovery of pectin from the pulp. The lots preserved by ordinary pasteurization suffered the most.

With regard to the stability of pectin and its subsequent recovery from stored dehydrated guavas, the conclusions arrived at were: (1) blanching of guava slices prior to dehydration improved the quality of pectin recovered from dehydrated slices; (2) for the recovery and quality of pectin, the critical and optimum temperatures for dehydration of guava were 160°F and 150°F respectively and (3) dehydrated guava could be stored at 5-7°C for six months without any material loss in recovery and quality of pectin.

The speaker then gave an account of the preparation and storage studies of liquid and powder pectin and stated that a good quality liquid pectin (7 fold concentrate) of the following characteristics could be prepared from guava; jelly grade 4, pectin 3.9 per cent (w/w), MeO 9.3 per cent and A.U.A. 89.1 per cent. However, the liquid pectin deteriorated rapidly during storage at 37°C and at room temperature, it being comparatively more stable at 5-7°C.

Powder pectin of fair quality could be prepared from guavas by alcoholic precipitation as well as by $AlCl_3$ methods (using 0.5 per cent $AlCl_3$). The powder pectin was found to be quite stable during six months' storage at 5-7°C. However, it deteriorated at higher temperatures (20 to 37°C).

Dr G. S. Siddappa and Dr J. S. Pruthi supplemented the talk and emphasised that the present study, which was a systematically conducted work for a *Thesis*, revealed that it was not worthwhile to utilize guava fruit for the production of pectin. However, the fruit could be used for the preparation of other useful products.

In the discussion that followed, the points raised related to, use of other varieties of guava, whether pectin was free from glucose, desirability of conducting the experiments over seasons, retention of pectin quality by checking respiration rate of stored fruits, whether the guava flavour persists in pectin, relation between methoxyl content and jelly grade, utilization of other fruits like figs for obtaining pectin, desirability of determining the actual yield of pectin from guavas by conducting fairly large-scale trials, physiological role of pectin in the plant, use of other parts o the plant possibly containing pectic substances.

Replying to the above it was mentioned that the guava pectin did not have any glucose. The reason for the presence of varying amounts of pectin in the case o fresh fruits and dehydrated guava vas the difference in the qualities of fruits used in different sets of xperiments. Further, small quantities of pectin might have been destroyed during the process of dehydration of the fruit. It was also pointed out that it was not economical to produce pectin from guavas on a large scale. Clarifying the relation between MeO content and jelly grade, Dr G. S. Siddappa said that even though jelly grade is related to MeO content, samples of commercial pectin could show higher jelly grade due to the presence of added salts. The speaker said that the other aspects *viz.*, pectin from other parts of the plants, physiological role of pectin, relation of respiration of fruit with pectin content during the storage of the fruit etc., could be studied with advantage.

In conclusion, Dr A. Sreenivasan, who presided, observed that production of pectin from guava would not be comparable in its economy with the other two sources *viz.*, apple and citrus fruits from which pectin is obtained as a valuable by-product using waste materials. He added that quite a number of products could be had from guava and it might not be desirable, as the author pointed out, to use the whole fruit to get pectin alone. He observed that the work deserved to be complimented as it was a carefully planned and systematic piece of work and from the academic point of view had opened up further lines of investigations.

S (*IS*) 22

Prevention of microbial spoilage in brine pickles, by M. S. Subba Rao and T. C. Soumithri (*June* 25, 1962).—Introducing the subject Mr Subba Rao said that pickles could be broadly classified into two groups: fermented, and unfermented. The type of spoilage in the case of fermented pickles could be softening, bloater formation, *Zapatera* spoilage, ropiness etc., while the predominant type of spoilage in unfermented pickle is softening. Softening in fermented pickle is due to the activity of bacteria, yeasts and fungi, or of pectinolytic enzymes present in certain parts of plants. In unfermented pickle, it is due to mould growth. Yeast growth does not appear to cause softening in unfermented pickles but the odour of yeast does appear to attract fruit flies which may incidentally carry infection.

The speaker briefly mentioned the work done on Indian pickles which is confined mostly to work done in this Institute. A survey of the information indicated that no data have been collected on pickles prepared by the traditional method.

Miss Soumithri, presenting the experimental data said that brine pickle samples of lime, mango and the Indian goose-berry were collected from houses and hotels to investigate the nature of spoilage under varied conditions. Analytical data based on 59 samples indicated that there was a wide range in the concentration of both salt and acid. The variation in salt content was between 8 and 22 per cent. Nearly 58 per cent of the samples had a salt content below 15 per cent and the incidence of microbial spoilage in this group was about 92 per cent. Pickles having a salt content of about 18 per cent remained in sound condition, irrespective of the raw material used.

In the case of lime, a minimum concentration of 15 per cent salt together with nearly 3 per cent citric acid was required to preserve the material in sound condition, whereas in the case of mango slices and gooseberry 17 per cent salt with at least 2 per cent acid was required to prevent the growth of micro-organisms.

The salt tolerance of the organisms present in the pickle was studied next. The medium used was Peptone Dextrose Broth with yeast extract and the concentration of salt in the medium ranged from 0 to 25 per cent. It was found that viable cells were absent, whenever the concentration of salt in the pickle was 18 per cent or more. At or below a salt level of 16 per cent, viable yeast cells or mould spores were present in the pickle irrespective of the acid concentration. About 14 samples contained yeast cells which could tolerate even 20 per cent salt in the medium. The micro-organisms isolated from the pickle in all cases were either yeasts or moulds: no bacteria were isolated. There were a few samples which, although they contained viable yeast cells which could tolerate 15 per cent of salt in the broth, did not manifest any evidence of growth in the pickle containing the same concentration of salt. Inhibition of growth in these pickles appears to be due to the presence of the naturally occurring inhibitory principles in the raw material, such as organic acids, essential oils and polyphenols.

Thus, from studies based on samples collected from houses and hotels, the minimum concentrations of salt and acid required to preserve the finished product adequately during storage were arrived at for each raw material.

Next, studies were undertaken on samples prepared in the laboratory in the traditional manner, to find out the basic changes involved in the process of curing. The trend of results confirmed the previous findings and it was found that though salt concentration is primarily important in preserving the material the maintenance of a proper balance between the salt and the acid was also very important. In the case of mango, it appeared that preservation of whole mangoes was easier compared to that of slices. The extraction of juice from whole mangoes is slower and lesser in quantity than from slices. Hence, less nutrients are available to the micro-organisms for their growth, and multiplication of cells is retarded. Comparing brining with dry salting, it was found that in the former method, there was a sharp fall in the concentration of salt and, therefore, unless the strength of the brine was maintained, after a certain stage (depending on the raw material) there was a rapid build up of yeast cells. In the case of gooseberries, a mild cooking helped to extract more of the polyphenols which supplemented the preservative action of salt against microbial spoilage. In all cases, moulds caused considerable softening of the stock due to their pectolytic activity during growth.

As it is difficult to maintain the salt and acid at critical levels in houses and hotels, the alternative method is to use a preservative. The preservative used should take care of any deficiency of salt or acid in the pickles. With this in view, an emulsion containing acetic acid, orange peel oil, mustard powder and turmeric powder was prepared. Acetic acid and orange peel oil were the effective ingredients, the former against moulds, the latter against yeasts. Turmeric was added because it helped to retain the fresh green colour, especially of mangoes; mustard powder was used for obtaining a proper blend and for masking to some extent the flavour of acetic acid. To obtain the required concentration of active ingredients the weight of emulsion that had to be added was 1/10 of the total weight.

It was found that the emulsion prevented growth of micro-organisms in pickles containing as little as 8 per cent of salt, whereas 18 per cent salt was required for preservation by the conventional method. The salt tolerance of the organisms after the addition of the emulsion was also studied. It was noticed that even though a large amount of inoculum was used growth was absent in the inoculated tubes.

Since the emulsion effectively inhibited microbial growth, attempts were made to use the emulsion during the curing process itself.

The data collected indicated that fruits cured in brine containing 10 per cent salt remained in sound condition, even at low concentrations of acid, when the emulsion was used. In the presence of a high concentration of acid, the emulsion could preserve fruits even in 6 per cent salt solution.

The speaker concluded by summing up the findings and indicating further lines of work.

In the discussion questions put were: related to the possible cause of the wide variations of salt content in domestic and hotel pickles, the ingredients that make up the preservative emulsion and its stability, the microbial load of the spices and of the salt used for pickling, the use of chemical preservatives, the volume of export trade in pickles, the possibility of some peroxidase being responsible for off-flavour and how to prevent it, and the method of selecting a taste panel.

The speakers replied that the variation in salt content could not be ascribed to any difference in the intended duration of storage, but rather to the practice of adding salt in proportion to the number of fruits and overlooking the variation in the size of fruits. Asafoetida and chilli powder when employed at the levels customary in pickles have no effect against micro-organisms and are added only for taste. The use of lemon peel oil instead of orange peel oil has yet to be tried. In oil pickles, the oil maintains anaerobic conditions and hence the pickles are not liable to suffer the type of spoilage described above. The microbial loads of the spices and of the salt were both found to be heavy, but there was no multiplication of organisms in the pickle due to the high concentrations of salt and organic acid, and the presence of tannins and essential oils. Sulphur dioxide (50 p.p.m.), sorbic acid (100 p.p.m.) and sodium benzoate have all been used successfully as preservatives by others. No work has been done till now on the effect of emulsion on the activity of pectolytic enzymes and peroxidases. The taste panel was selected so as to include persons who were accustomed to vinegar and mustard in pickles and those not used to these two ingredients. 3520 tons of pickles and chutneys valued at Rs 1,760,000 were exported in 1960-61.

Concluding, the President, Dr A. Sreenivasan, remarked that whenever traditional methods are studied one must not only follow the empirically discovered paths, but also try to evolve new patterns. For example, a significant finding of the present study was that a concentration of salt much lower than the usual would be quite adequate when used in conjunction with an emulsion of the traditionally employed, natural, preservative agents. One could then easily find new outlets of work such as the formulation of various emulsions, differing in taste and flavour, so that they could be added to a cured, and perhaps dried, stock of bland raw material to give a pickle of the desired taste. That the use of certain antibiotics (such as nisin) might be possible should also be borne in mind.

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Information and Advice

IN pursuance of the policy of rendering technical aid to food industries in the country, the CFTRI supplies information on technical and other problems, carries out analytical work and undertakes short- and long-term investigations on behalf of the industry, besides bringing out publications containing important technical advances in different aspects of Food Science and Technology. The Institute deals with a number of enquiries from various food industries and others interested in Indian processed food products. A few of the enquiries answered are reproduced in this section.

E (*IS*) 37

Fruit beverages

As per the Fruit Products Order, the products manufactured should have the following specifications.

	%Juice w/w	%Total soluble solids w/w
Fruit squash and nectar	25	40
Fruit syrup	25	65
Fruit crush	25	55
Fruit cordial	25	30

The acidity of the above mentioned products shall not exceed 3.5 per cent expressed as anhydrous citric acid. Sweetening agents other than sugar, invert sugar or glucose should not be added to the products in any case.

E (*IS*) 38

Safflower seed oil

'Kardi Oil' is the oil expressed from safflower seed (*Carthamus Tinctorius* Linn.) which is extensively grown in Bombay and Mysore states and which is used mainly for edible and illuminating purposes and for the manufacture of soap. It is often used as an adulterant of ghee or sesame oil. In Bombay, safflower seeds are mixed with groundnut kernels and sesame seeds and crushed together to yield the sweet oil of commerce.

From the feeding trials conducted on rats with safflower seed oil and ghee, the digestibility co-efficients obtained are 98.7 and 98.8 respectively.

Besides its use as an edible oil, it is classed as semidrying and serve as a vehicle for paints, varnishes and enamels and in the production of oil modified alkyd-resins.

E (*IS*) 39

Brewed vinegar

Vinegar (brewed) is a liquid derived from various substances containing sugar and starch by alcoholic and subsequent acetic fermentation and shall contain at least 3.75 g. of acetic acid per 100 cc. But synthetic vinegars are made by diluting glacial acetic acid with water in the proportion of 1:24 in order to have an acetic acid content of about 4 per cent in the final product and adding caramel colour in adequate quantities. Therefore it is clear that acetic acid after proper dilution can also be used instead of vinegar.

E (*IS*) 40

Coconut utilization

A plant designed and manufactured by Messrs Krauss Maffei, Munchen, W. Germany is functioning at this Institute for the extraction of oil, protein and carbohydrate fractions from fresh raw coconuts.

For the production of copra, suitable driers in different capacities are being manufactured by: Messrs Tyneside Foundry and Engineering Co. Ltd., Elswick, New Castle-on-Tyne, England and Messrs A. S. P. Overseas Private Ltd., N.R.M.A. House, 26 Ridge Street, North Sydney, N.S.W., Australia. We suggest to contact Messrs Bentley Produce Company, Bedford Buildings, Coonoor P.O., Nilgiris who are the agents for the driers.

E (*IS*) 41

Defatted rice bran

The oil left over in the extracted bran is about 2 per cent. On account of its low fat and low moisture content, the extracted bran is expected to keep better during storage than the original rice bran. Since the extracted bran is found to retain about half to two-thirds of B-vitamins as well as tocopherol originally present in bran and it contains about 14-16 per cent protein and 10-11 per cent mineral matter, this can serve as a good cattle feed.

E (*IS*) 42

Arecanut

Arecanut is used as fresh ripe fruit, as dried ripe fruit and as cut and boiled and dried product prepared from the green fruit. There is no great difficulty in the case of the two dried products regarding storage provided care is taken about proper packing and storage in the godowns. In respect of storage of fresh fruits, traditional method is to keep them in running water or stagnant water, both of which result in retting and fungus infection. An improved method of steeping in preservative solutions have been developed in this laboratory for the proper storage of fresh fruits.

E (*IS*) 43

Antioxidants

The following antioxidants can be used as preservatives in edible oils and fats for prevention of oxidative rancidity.

Antioxidant		*Quantity on fats or oils*
Propyl gallate	...	note more than 0.01%
Gum guaiac + phosphoric acid	...	0.05% + 0.002%
Butylated hydroxyanisole + propyl gallate + citric acid	...	0.01% + 0.003% + 0.002%

E (IS) 44

Composition of milks/curds

Chemical composition of vegetable milk curd from grounduts, Cow's milk curd and skimmed milk powder are given below:

	Vegetable milk curd	*Cow's milk curd*	*Skimmed milk powder*
Protein (%)	3.00	3.30	38.0
Fat (%)	3.50	3.75	0.1
Carbohydrate (%)	3.07	4.85	51.0
Calcium (mg/100g.)	110	110	137
Iron (mg/100.g)	1.47	(0.2–0.5ppm)	1.4
Phosphorus (mg/100g)	102	70	110

E (IS) 45

Tamarind seed flour

A new sizing material for cotton yarn—Dehusked tamarind seed contains 58.5 per cent pectin and is well suited as a substitute for starch in both pure and heavy sizes. The aqueous solution of tamarind seed powder has a higher viscosity than a starch solution of equal concentration and the viscosity is further increased by the addition of borax. The addition of borax is advisable when treating fine fabrics because it neutralizes the slight acidity of the tamarind seed solution (pH 5.7 for a 0.5 per cent solution). Seed powder suitable as sizing material is prepared by heating the seeds to 150°F for 10-15 minutes, removing the seed testa, soaking in water for 8-10 hours, washing, drying and powdering. An aqueous solution of the powder 5 per cent is used for sizing. Practical tests with gray cotton yarn showed tamarind seed compared favourably with standard starch size. $MgCl_2$ can be used with tamarind seed because it reacts with the constituents but $ZnCl_2$ is a suitable addition. Tamarind seed is less susceptible to enzymic action than starch.

Notes and News

NEWS BRIEFS

Improved pickling method: A new method of preparing sweet cucumber pickles has been developed at the Canadian Department of Agriculture's Modern Experimental Farm. Slices pickled by the new method are firm and crisp and the colour is evenly dispersed, it is reported.

Describing the process, R. B. Hyde, engaged on developing the method, says gases are removed from the sliced cucumbers under high vacuum and replaced by water or a dilute syrup. Slices are packed into jars containing a sweet spiced vinegar solution and pasteurized.

Cucumbers pickled by this method weigh up to 10 per cent more than when fresh, in contrast to cucumbers pickled by the usual methods which generally shrink considerably.

The Modern Experimental Farm method appears to have considerable commercial possibilities, reports *Food Processing and Packaging*. It would enable the thick cucumber slices used in sweet mixed pickles to be packed directly from fresh cucumbers without shrivelling, eliminating the customary slow method. Also, the quality and yield of pasteurized pickles from fresh sliced cucumbers may be improved by adding a vacuum treatment to the regular commercial process. (*Food Technol. Austr.*, July 1962, p. 313).

✓**Improved sulphuring of fruit for drying:** A new method has been developed by J. A. Kitson and F. E. Atkinson at the Fruit and Vegetable Processing Laboratory of the Canadian Department of Agriculture (Summerland, B.C.) for treating apricots with sulphur dioxide. This technique reduced treatment time from 45 hours to one hour or less.

The halved fruit is placed in trays and subjected to a vacuum for ten minutes in a vacuum chamber, the vacuum is then released with sulphur dioxide, and the fruit held in the gas until the desired concentration is reached. The treatment can also be used for resulphuring dried fruits. (*Food Technol. Austr.*, July 1962, p. 313).

Influence of gas packing and flavouring additives on the storage life of dried mutton mince: In a study of the shelf life of air-dried mutton mince under widely varying conditions, three packing methods, air, nitrogen, and block packs were compared at storage temperature of 0, 10, 15, 25 and 30°C for periods up to 3 years.

Preference for the packing methods was in the order of nitrogen, block, and air packs. Exclusion of oxygen from the packs improved the shelf life at all five temperatures of storage.

Three well-known seasoning mixtures (sausage, bologna, and frank-furter seasoning) were added n two concentrations (1 and 2 per cent of dried weight) to air-dried mutton mince packs prepared by four methods (air, nitrogen, as blocks, and as fat blocks). Similar packs without seasonings were prepared containing monosodium glutamate in two concentrations (0.75 and 1.50 per cent of dried weight). All packs were examined regularly during storage at 77°F over a period of 30 months.

To avoid development of unpleasant foreign flavours it was necessary to separate the seasoning mixtures from the meat during storage, but for monosodium glutamate this was unnecessary.

When the seasoning mixtures were stored in separate *Cellophane* envelopes in the packs, the addition of the three materials to air-dried mutton mince improved acceptability and substantially prolonged shelf life: monosodium glutamate was practically ineffective in this respect. The higher concentrations of the seasoning additives seemed very close to optimum but the relative acceptabilities depended on personal preference (*Food Technol. Austr.*, July 1962, p. 317).

Freeze-drying meat products: Wilson and Co. of Chicago produce a variety of freeze-dried products ranging from shredded chicken, beef for stews and casseroles, rib-eye steak, and boneless pork chop to hamburgers and even shrimps. Most of these are distributed to firms specialising in supplies for hunters, fishermen and miners, but certain products are also supplied to the U.S. Armed Forces.

All meats must be bone-free and the size of the pieces is carefully controlled varying from 3/8 in. × 3/8 in. to 1 in. × 1 in. depending on customer requirements. Products are frozen at temperatures not exceeding —10°F and dehydrated in *Stokes* equipment for from 7 to 24 hours at an absolute pressure of from 0.1 to 0.75 mm. The hollow shelves on which the product is placed are heated by circulating methylcellusolve through them and moisture vapour from the product is condensed and frozen on plates, positioned directly behind the chamber, chilled by liquid ammonia. Non-condensible gases are taken out by the vacuum pumps. After each operation the ice is melted by circulating steam or hot ammonia gas through the condenser.

Some products are nitrogen-packed in cans or large drums, meat bars are wrapped in foil with a paper slip cover, and some of the camper products are packed in film pouches (*Food Technol. Austr.*, July 1962, p. 317).

Determination of filth in tomatoes and tomato products: A method which combines the isolation of fly eggs, maggots and insect fragments from tomatoes and tomato products has been described by E. W. Coulter in the *Journal of the Association of Official Agricultural Chemists* (**44,** 339, 1961).

This proposed method is more rapid than the two official methods and is based upon the use of a 5 per cent solution of sodium ethylenediamine tetra-acetate. This has been found to break down pectinous residues thus enabling the material to be sieved without affecting the fly eggs. The remaining material is then transferred to a filter paper and examined microscopically (*Food Technol. Austr.*, July 1962, p. 330).

Tests for freshness of fish: A test which determines the age and quality of seafoods by colour is being recommended by The Marine Laboratory of the University of Miami, Miami, Fla., U.S.A.

Called the Nessler reagent, this chemical test will give a light yellow colour on samples of good quality fish, a deeper yellow on inferior fish and an orange colour on spoiled fish. The test is claimed to be much more reliable as a means of establishing product age and quality than either the bacterial or odour tests.

Drawbacks of the method are instability of the colour which must be recognized as soon as the test is completed and various amines which can sometimes influence the colour: Nevertheless, the advantages are substantial, since this test is much more accurate than bacteriological tests and much quicker.

Information can be obtained regarding it by writing to the University. The chemicals necessary for its use are purchasable in any good chemical supply house (*Food Technol. Austr.*, July 1962, p. 347).

Waxes used in food packaging: Waxes used in food packaging are '*chemically clean as a whistle*' according to Dr Phillipe Shubik, professor at the Chicago Medical School and director of the American Petroleum Institute's $500,000 research programme on the safety of petroleum waxes for food packaging. Speaking before a recent meeting of the Chicago Section of T.A.P.P.I., Dr Shubik said that in his opinion and as a result of more than four years of research work, all refined petroleum waxes used in food packaging should be accepted as safe under the terms of the Food Additives Amendment.

Dr Shubik has conducted many research projects dealing with petroleum waxes as a cancer-producing substance. However, the studies proved negative and no constituents were found in the waxes tested in sufficient quantities to produce cancer, Dr Shubik emphasized. From a group of some 200 commercially used waxes, 36 were analyzed and none found to contain established cancer-producing agents. These findings were confirmed by an analytical test method which could detect one part per billion and measure one part per 100 million.

Factual data collected from the completed research project will be compiled into a written report, and this report and a petition will be filed with the Food and Drug Administration, asking for clearance of waxes as a food packaging material component (*Food Technol. Austr.*, Aug. 1962, p. 373).

Rancidity Testing of fats: In a paper entitled *The Chemistry of the 2-Thiobarbituric Acid Test for the Determination of Oxidative Rancidity in Food. I. Some Important Side Reactions*, B. G. Tarladgis, A. M. Pearson, and L. R. Dugan, Jr. (*J. Am. Oil Chemists' Soc.*, 39, 34, 1962) present evidence by U.V., Visible, and I.R. spectra as well as by paper and column chromatography of variously treated T.B.A.-acid reagents that the structure of T.B.A. is altered upon acid-heat treatment. A more pronounced but similar effect results from the treatment of the T.B.A. with hydrogen peroxide. Some of the degradation products of T.B.A. absorb at the same wavelength as the T.B.A.-malonaldehyde complex, as do many compounds which are reported in the literature to react with T.B.A.

The significance of these findings in respect to the quantitative aspects of the text for the determination of rancidity in food products is discussed (*Food Technol. Austr.*, Aug. 1962, p. 403).

Continuous yeast production: The Dovercourt Yeast Factory in Essex, England, is producing baker's yeast without alcohol by a continuous fermentation process. The plant produces 130 tons of yeast per week.

The yeast is grown under sterile conditions from single-cell cultures at a rate of two tons per hour. The essentials of the process are the growing of a yeast culture in a nutrient medium of molasses, phosphate, ammonia, and water under controlled temperature, acidity, and aeration. The nutrient medium, or wort, is added continuously to each stage, and the yeast separated continuously after completion of propagation, in the final 'ripening' vessel. Theoretically, the process could proceed indefinitely, but in practice it is limited to about eighty hours because of the difficulty of maintaining sterility for longer periods. The introduction at any stage of contaminants results in rapid propagation of unwanted organisms.

The principal raw material is a blend of beet and cane molasses used in solution, the proportion of cane molasses varying from 20 to 50 per cent according to availability and requirements. In the process, the preparation of the molasses solution, its sterilization, and the control of its concentration are all carried out continuously and automatically.

Nitrogen requirements for the yeast are supplied by aqueous ammonia. The ammonia is delivered in 2,000-gallon tanker loads, and stored in underground tanks. Average use is about 3,000 gallons per week.

The oxygen requirements of the yeast are provided by three electrically driven blowers with a total output of 24,000 cubic feet of free air per minute.

The culture, grown from a single cell isolated by micro-manipulation, is obtained from the Central Research Department of Distillers Company, Ltd., at Epsom, England. This is delivered weekly in half-gallon containers, and is substantially increased in a culture vessel before being used in the main process.

The various feeds, which include water, molasses, phosphate, nitrogen, anti-foaming agent, and sulfuric acid, are metered automatically into each fermenter. The sterilized molasses solution is added through glass dose vessels controlled by an electronic timer. The supply of phosphate is regulated by a flow meter fitted with a warning device to indicate any deviation from correct flow rate. The sulfuric acid addition is controlled by a pH recorder-controller. Water addition is indicated continuously by flow meters—again, with deviation warning devices.

The first stage in the process is to increase the ½ pound of cultured seed. This is done in a 1,000-gallon stainless steel vessel maintained under sterile conditions in a sealed culture room. The culture is transferred aseptically to this vessel and grown in a nutrient medium for about 20 hours. All possible care is taken to ensure that the culture room is kept as near to sterility as possible.

Chemical and nutrient feeds are cut off and aeration greatly reduced in the final, or 'ripening' vessel. At the end of the on-stream period, all feeds to the first fermenter are stopped, and the run-down phase starts. During the run-down phase the contents of the first fermenter and succeeding fermenters are passed forward through the system, and yeast continues to be fed to the separators at the same rate as during the on-stream period.

For an average run, the operating time-table is: build-up phase, 27 hours; on-stream, 63 hours; run-down, 17 hours; giving a steady flow to the separators for 80 hours.

The yeast drops to the automatic extruding, cutting, and wrapping machines. It is extruded as a solid cake, and cut up into one-pound blocks. The yeast blocks are wrapped and packed in 28-pound cartons, and placed in cold storage. At no point is the yeast touched by hand (*Food Technol.*, July 1962, p. 32).

Instrument analysis of non-volatile materials: Wilkens Instrument and Research, Inc., has introduced a new model 'Pyrolyzer' that provides a convenient method for the analysis of non-volatile materials when attached to any hydrogen-flame gas chromatograph.

The method consists of applying a small amount of material to a platinum coil and then electrically heating to high temperatures after assembly has been placed in the carrier gas stream of the gas chromatograph.

Materials such as rubber, plastics, alkaloids, paint films, fibers, tars, etc., decompose at high temperatures to give characteristic breakdown products that are volatile. The gas chromatograph pattern of these volatiles helps characterize the parent substance.

The firing circuit for the pyroly-s coil is simple. The current for he coil, read on a DC ammeter, is egulated with a powerstat that owers an 8-V transformer and two 0-amp diodes. The current is urned on with an automatic return ever switch. By using a graph of olor-temperature versus current, he temperature of pyrolysis is redetermined by firing the coil utside of the chamber and noting he color of the platinum coil.

Further information on the Aero-raph Model A-425 'Pyrolyzer' s available from the company at P.O. Box 313, Walnut Creek, Calif. (*Food Technol.*, July 1962, p. 60).

Detector attachment: Flame onization detection is provided by a versatile unit that adapts to programmed gas chromatographic apparatus or other thermal conduc-ivity apparatus. With separate emperature controller and recorder dded, the F & M Scientific Corporation, Avondale, Penn., Model 1609 becomes a separate gas hromatograph. Used with a pro-grammed high-temperature appara-us it adds a second detector with a wide range of column systems. The detectors can be maintained ndependently or switched back and forth without changing components. The unit is said to extend perform-nce and sensitivity of present instruments 100 to 1000-fold in trace organics' analysis in air or aqueous solutions (*Food Technol.*, July 1962, p. 60).

Gas chromatographs: Two new gas chromatographs have been introduced by Marryat and Place Ltd. They are claimed to be compact and have few controls, yet to provide considerable flexibility in the range and length of columns which may be used and the range of sensitivity which may be selected. The fixed temperature model has an oven enclosed in an aluminium-sheathed element controlled by a transistorised anticipatory tempe-rature controller. An over-riding 'boost' control with automatic cut-out enables operating temperature to be reached in under 10 minutes without danger of overheating.

The second model, the program-med temperature type, operates at temperatures up to 350°C with linear programmes from 4-20°C per minute selected by a control knob. Heat is transferred to the column by a non-recirculating high velocity air stream heated by a 1 Kw. element controlled by a saturable reactor (*Food Manuf.*, Aug. 1962, p. 390).

New flavour enhancer: A new compound claimed to enhance the flavour of a wide variety of food products has recently been introduced by the Chemicals Division of Pfizer Ltd. Sold under the trade mark *Veltol*, the compound is a fine white powder which, it is said, increases the flavour of foods, enhances their aroma, and suppresses any harsh flavour. It is claimed to be particularly effective in chocolate products, ice cream, soft drinks, sugar and flour confectionery, and processed fruits, vegetables and soups. Lack of a sufficiently dependable source of supply has, until present, prevented its general use in the food industry. *Veltol* is now available to food processors in unlimited quantities (*Food Manuf.*, Aug. 1962, p. 397).

INDIAN PATENTS

74769. *Automatic single bill constant weight feeder:* Conveyor belt divided into a feeder section and a weighing section by two drums, one of the drums being driven by a servometer and the other being disposed swingably and adjustably opposite the direction.—Prerovske strojirny, narodini podnik. (*Gazette of India*, Part III —Sec. 2, 1962, p. 233).

75374. *Insecticide formulations:* Comprises of phosphorous compounds, a toxicologically inert solid carrier material and a minor amount of at least one phenol.—Shell Internationale Research Maatschappij N. V. (*Gazette of India*, Part III—Sec. 2, 1962, p. 234).

75903. *Ice cream container:* Comprises a body blank having body panels folded along longitudinal bend lines and joined along a longitudinal seam to form a hollow polygonal body.—Foils Packaging Corporation. (*Gazette of India*, Part III—Sec. 2, 1962, p. 235).

74955. *Container and end closure:* Comprises four panels and a tab integrally inter-connected at four longitudinal bend lines, the blank has a transverse crease line crossing the bend lines at right angles and divide the blank into longitudinal side panels.—Foils Packaging Corporation. (*Gazette of India*, Part III—Sec. 2, 1962, p. 241).

75027. *Colouring matters and food products coloured thereby:* An aldehyde, the carbonyl double bond of which is in conjugation with a carbon-carbon double bond, is condensed with a pentane-2: 4-dione at a temperature not greater than 170°C in the presence of boric oxide, a primary aliphatic amine and, if desired, a trialkyl borate.—Unilever Limited. (*Gazette of India*, Part III—Sec. 2, 1962, p. 241).

75703. *Polyvinyl chloride, resin stabilizer system, particularly for use in food packaging:* Consists of a polyvinyl chloride resin and a stabilizer system comprising the calcium salts of mixed fatty acids, zinc salts of mixed fatty acids and sorbitol.—Argus Chemical Corporation. (*Gazette of India*, Part III —Sec. 2, 1962, p. 253).

75771. *Packaging machine:* Forming tube around a mandrel and sealing means on carriage forming successive transverse seals in different planes and opening on each return stroke of the carriage and closing on the tube in different planes on successive forward strokes of the carriage.—Packaging Frontiers. (*Gazette of India*, Part III—Sec. 2, 1962, p. 266).

75265. *Improvements in or relating to the manufacture of paper strings and paper straps which are used for packaging:* Comprising (*a*) the step of rewinding a large paper roll of craft paper of high tensile strength into smaller rolls (*b*) cutting each said smaller rolls into smaller reels of tapes of the required size and (*c*) the step of spirally spinning the tape from each of said reels into paper strings of the required thickness.—K. J. Mody. (*Gazette of India*, Part III—Sec. 2, 1962, p. 274).

76540. *Process and apparatus for the recovery of sugar from sugar cane:* Comprises breaking and masticating chopped cane pieces, then disintegrating and continuously diffusion processing to extract sugar.—Rietz Manufacturing Co. (*Gazette of India*, Part III—Sec. 2, 1962, p. 277).

76742. *Improvements in or relating to drying of wet grains and seeds:* Raising the temperature by indirect heating by steam or gas at a temperature ranging between 250° to 250°F and simultaneously blowing hot compressed air.—E. G. K. Murti. (*Gazette of India*, Part III—Sec. 2, 1962, p. 284).

73989. *Fungicidal compositions containing hydantoin compounds:* Comprising hydantoin compounds such as 4′-methyl-cyclo-hexane-N-trichloro methylmercapto—5 : 5—spirohydantoin, and a carrier therefor.—Imperial Chemical Industries Limited. (*Gazette of India*, Part III—Sec. 2, 1962, p. 289).

74797. *Separation of amylaceous components of starch and amylose and amylopectin separated thereby:* Forming solution of starch in water at 250°F, cooling, below atmospheric boiling point and above 120°F, concentration of starch being 2.5 per cent maintaining at this temperature range until amylose-rich solid forms and grows and separating same.—A. E. Staley Manufacturing Co. (*Gazette of India*, Part III—Sec. 2, 1962, p. 290).

75304. *Apparatus and method for softening water:* A first valve element moveably mounted to occupy a service position and a second position for backwashing and regenerating and having first and second valued means for hard water inlet.—Water Refining Co. Inc. (*Gazette of India*, Part III—Sec. 2, 1962, p. 290).

74223. *Insulating containers:* Comprising a double walled chamber the upper end of the inner wall bent outwardly to form a seat to cover the clearance between the double walls at upper ends, the upper end projecting beyond the outer wall, the upper end of the outer wall bend outwardly the projecting edges of the two walls being crimped together after an insulating material is sandwitched between the two walls and the base.—P. K. Sanghvi and B. K. Sanghvi. (*Gazette of India*, Part III—Sec. 2, 1962, p. 301).

75397. *New process for the preparation of vitamin B_{12} and its analogues:* Fermenting a variety of the genus Propioni-bacterium which produces cobalamine in anaerobic phase in the presence of a precursor of the basic constituent of the nucleotide of the desired cobalamine.—Uclaf. (*Gazette of India*, Part III—Sec. 2, 1962, p. 302).

76510. *Impeller type grain lifting apparatus:* Apparatus comprising an impeller mounted on a horizontal drive shaft and a casing for enclosing it having a grain feed opening, said impeller comprising a number of impeller blades arranged circumferentially thereof at regular intervals each of said blades including a multitude of parallel resilient filaments to form a sheet extending radially to terminate adjacent the inner periphery of the impeller casing.—Iseki Agricultural Machinery Mfg. Co., Ltd. (*Gazette of India*, Part III—Sec. 2, 1962, p. 304).

FOREIGN PATENTS

B.P. 857,868. *Phosphate-modified starches:* An alkali metal phosphate-modified starch, obtained by interaction of ungelatinised starch with an alkali metal phosphate at 120-175°, is dispersed in water, then an inert O-containing water-miscible org. liquid (MeOH or EtOH) is added (to 35-65 vol.-per cent concn.), to effect separation of an alkali metal phosphate-modified starch of higher viscosity that of the starting product. The high-viscosity compounds are useful as thickening agents in food products (soups, ice creams, puddings, etc.) and in other technologies.—International Minerals and Chemical Corp. (*J. Sci. Fd. Agrc.*, April 1962, p. i-187).

B.P. 854,142. *Bacteriologica sterilisation:* The end-point of a fumigation or bacteriological sterilisation process (e.g., in the sterilisation of pharmaceutical products, foodstuffs, etc.) with a lethal gas is indicated by means of a device comprising a liquid indicating composition capable of absorbing the lethal gas and producing a colour change. The composition (which may be a pH indicator) is contained in an envelope which is permeable to the gas but is chemically resistant thereto and to the indicating composition. For ethylene oxide (I) the absorbing solution is saturated $MgCl_2$ solution with 0.045 per cent of 0.16 per cent of aq. bromocresol purple solution and HCl to 0.1N concn. which turns yellow in presence of I, the time required depending on its concn.—Boots Pure Drug Co. Ltd. (*J. Sci. Fd. Agric.*, April 1962, p. i-199).

B.P. 861,195. *Hydrolysed starch syrups:* Improved hydrolysed starch syrups of low dextrose equiv. and having high stability to haze formation and low η, which are especially useful as brewer's body syrups or as additives for aiding spray-drying of sol. products, are obtained by (*a*) hydrolysing starch with acid to a dextrose equiv. value of 18-35, (*b*) neutralising and filtering the hydrolysate, (*c*) treating the hydrolysate with an enzyme prep. containing α-amylase to hydrolyse partially the high-mol.-wt. dextrins without substantially increasing the dextrose equivalent, and (*d*) concentrating the resulting liquid to syrup.—Corn products Co. (*J. Sci. Fd. Agric.*, May 1962, p. i-232).

B.P. 858,340. *Cheese making:* A ethod of making hard Cheddar eese comprises applying pressure , and increasing pressure on, a spension of curds in whey while moving the whey therefrom—e whey initially having an acid ntent of 0.16-0.25 per cent and a mp. favourable to acid develop- ent. The amount and rate of crease in pressure is correlated ith the rate of acid development such a manner as to achieve a duction in water content to 35-40 er cent and an increase in acid ntent to 0.5-0.8 per cent. Appa- tus is figured and claimed.—hed-O-Matic Corp. (*J. Sci. Fd. lgric.*, May, 1962, p. i-239).

B.P. 858,253. *Food compositions:* ilk (1 gal.) is heated with sugar >96, preferably 30-50 oz.) at 208 212°F for 25-35 min., then flav- uring agent and a softening agent glycerol or invert sugar) are added. he mixture is now heated at 203-07°F (24-35 min.), at 198-202°F 15-25 min.), at 193-197°F (8-12 nin.), and at 188-192°F (8-12 min.), hen the temp. is gradually reduced o 160°F during a long enough eriod to effect thickening, while tirring continuously. There is thus btained a food product suitable for se as a spread (on bread or bread nd butter), as a sponge filling, or s a cake icing.—I. S. Philp. (*J. Sci. Fd. Agric.*, May 1962, p. i-239).

B.P. 858,333. *Flavouring sub- tances:* A flavouring substance, specially with a meat-like taste, is produced by heating (boiling) an amino reagent, viz., cysteine (1) with a furan compound (0.05-0.75 mol.) in presence of water at pH 2-7. The furan compound is preferably furan, furfuraldehyde, furfuryl alcohol, furoic acid or furfurylamine. The cysteine may if desired be partly replaced by at least one other amino-acid selected from arginine, glutamic acid and proline or by at least 3 amino-acids selected from glycine, α-alanine, β-alanine, threonine, lysine, leucine, isoleucine, serine, valine, histidine and cystine (1-4 pt. per pt. of cysteine).—Unilever Ltd. (*J. Sci. Fd. Agric.*, May 1962, p. i-243).

B.P. 860,942. *Fungicidal and insecticidal compositions:* A fungicidal and insecticidal composition of improved suspension properties in paraffinic oils comprises a solid fungicide or insecticide (e.g., Cu oxychloride, 5-10 lb.), and a mixture (1 gal.) of paraffin oil $\eta^{38} < 3$ cS (50-96) and vegetable oil (5-50 vol.- per cent), e.g., rapeseed oil.—Esso Research and Engng Co. (*J. Sci. Fd. Agric.*, June 1962, p. i-271).

B.P. 861,829. *Treating fibrous materials containing carbohydrates:* To increase the protein content of cereal products (I) containing carbohydrates (e.g., maize, wheat, sugar-beet pulp, etc.) and obtain therefrom products suitable as source of assimilable N for ruminant animals, I are heated (preferably in presence of added steam) in a closed vessel under pressure (30-220 p.s.i.) for 1-7 min. in presence of $\sim$0.5-4 per cent by wt. of urea (advantageously plus a small amount of S).—Grossman Inventions (Private) Ltd. (*J. Sci. Fd. Agric.*, June 1962, p. i-278).

B.P. 861,439. *Fractionation of a stock of cereal endosperm particles:* Cereal (wheat) endosperm particles (viz., flour from which hull, germ and bran have been removed) are subjected to impact grinding so as to shell out and release a substantial amount of the more cohesive whole starch granules while simultaneously comminuting the less cohesive protein matrix substances, then the ground particles are air-separated at a critical cut to provide a coarse fraction of greater starch content than the original stock and also to provide a high-protein fine fraction. The starch fraction is especially characterised by improved baking properties.—Pillsbury Mills Inc. (*J. Sci. Fd. Agric.*, June 1962, p. i-281).

B.P. 862,811. *Dry separation of starch and protein from flour or antecedent milling stocks:* Flour is treated to produce a fraction of high per cent protein and a fraction of low per cent protein by subjecting it to communition such that the starch granules embedded in the protein continuum are released without damage while the continuum is fragmented into particles of $<20\mu$. The flour is then classified into high-protein particles of 13-15 μ and low-protein particles of 15-22 μ.—Research Association of British Flour-Millers and H. Simon Ltd. (*J. Sci. Fd. Agric.*, June 1962, p. i-281).

B.P. 861,117. *Dehydrated mashed potato:* A dehydrated mashed potato product which on reconstitution affords a food-stuff of improved texture, is obtained by incorporation (at any convenient stage) of one or more edible org. esters with surface-active and emulsifying properties, e.g., glyceryl monostearate, oleo-stearate or monolaurate; or sorbitan, polyoxyethylene or polyoxyethylene monostearate (<0.05 wt.- per cent).—M.P.P. (Products) Ltd. (*J. Sci. Fd. Agric.*, June 1962, p. i-287).

B.P. 861,773. *Concentrated fruit juice:* Conc. fruit juice, free from air, is produced by evaporating water from fruit juice and admixing the concentrate with a small amount of fresh juice (for restoration of flavour) which has been stripped with inert gas to remove any O_2 contained therein.—Union Carbide Corp. (*J. Sci. Fd. Agric.*, June 1962, p. i-287).

Pest control products: Of the 9 drafts issued for pest control products, one relates to the Specification for Hand-Compression Sprayer for Agricultural Use, five cover new materials and the remaining three are draft revisions of the existing standards. The new materials for which specifications have been issued are:

(*a*) Phenyl Mercury Salicylate, Technical;

(*b*) Phenyl Mercury Acetate, Technical;

(*c*) Stabilized Methoxy Ethyl Mercury Chloride;

(*d*) Parathion, Technical; and

(*e*) Parathion Emulsifiable Concentrates.

The draft specifications for the following are revisions of the standards indicated against each:

(*a*) Dieldrin, Technical (IS: 1052-1957);

(*b*) Dieldrin Water Dispersible Powder Concentrates (IS: 1053-1957); and

(*c*) Dieldrin Emulsifiable Concentrates (IS: 1054-1957).

(*ISI Bull.*, May-June 1962, p. 186).

Cheese vats: Till recently cheese was an imported item in India. However, it is now being made on a small scale in milk-processing units as a by-product. The vats covered in the draft Specification for Cheese Vats are mainly intended for these small scale manufacturers. The draft prescribes constructional dimensions and requirements for cheese vats of 250-litre and 500-litre capacities. (*ISI Bull.*, July-Aug. 1962, p. 247).

Methods of dairy plant control: Methods commonly used for control work in liquid milk plants are covered in the draft Indian Standard Methods of Test for Dairy Industry, Part V Methods of Dairy Plant Control. Other parts of this standard cover the following:

Part I—Rapid Examination of Milk,

Part II—Chemical Analysis of Milk,

Part III—Bacteriological Analysis of Milk, and

Part IV—Method of Determination of Freezing Point of Milk.

This comprehensive standard is being prepared for achieving uniformity and for facilitating the interpretation and comparison of results. (*ISI Bull.*, July-Aug. 1962, p. 247).

Chillies and mustard powde A series of specifications for spic and condiments is being issued I ISI. The latest additions to th series are specifications for (chillies and (*b*) mustard powde The gradation of chillies has be suggested on the basis of siz colour, moisture, discoloured po pedicled and clipped pods, loo seeds, foreign matter, and brok and damaged pods. In the dra specification for mustard powd two types have been prescribe namely mustard powder and cor pounded mustard powder. (*I Bull.*, July-Aug. 1962, p. 248).

Bottle coolers: General co structional requirements and m thods for establishing ratings a testing of bottle coolers operated vapour compression type refriger ing machines have been covered the draft Specification for Bot Coolers. The ambient temper tures of bottle coolers covered this draft are 43°C and 32°C. T cooling water temperature specifi ranges from 6° to 10°C. (*ISI Bu* July-Aug. 1962, p. 248).

Food Abstracts

THIS section contains abstracts of papers on Food Science and Technology selected so as to serve the needs of food and allied industries in India and is divided into three parts. Part I comprises abstracts of papers published by the CFTRI, Mysore, reprints of which can be had from the Institute on request. Part II consists of abstracts of papers published in important Indian journals. Part III contains abstracts of important articles from foreign journals.

PART I (Cftri)

Studies on the antihelminthic activities of seeds of *Carica Papaya* Linn., by Krishnakumari, M. K. and Majumder, S. K. *Ann. Biochem. & exptl. Med.*, 1960, **20**, (Suppl.), 26.—When worms belonging to the species *Toxascaris transfuga* (from the Indian sloth bear), *Ascaris lumbricoides var. suis* (from pigs) and an *Ascaris* sp. (from the polar bear) were exposed for 18 hours at 34°C to a Ringer-Locke solution (50 c.c.) containing papaya seed powder (1 g.) they died after 72, 61 and 97 hours respectively. The vermicidal agent is insoluble in the usual organic solvents but dissolves readily in distilled water and dilute alkalis. The powder appears not to loose its effect after 6 months of storage at room temperature (24°C and 29°C). It stores well under vacuum, nitrogen, and CO_2. —K.M.D.

Composition and properties of dried peas in relation to their suitability for canning, by Lakshminarayana Setty and Siddappa, G. S., *J. Sci. Fd. & Agric.*, 1961, **8**, 537.—Physical properties such appearance, shape, water-abso tion capacity and specific gravity dried peas are related to their ca ning quality. *W. K. Marrowfat* a *E. W. Marrowfat*, which are typi wrinkled seeded varieties and whi have a high water-absorption ca city are good for canning. (the other hand, smooth-seed varieties like *R.O. Dutch Blue* a *S.O. Dutch Blue* with low wat absorption capacity and an abn mally high swelling ratio on p cessing, often give a mealy cann luct. Others, like *Blue Dutch*, *S. Dutch Blue* and *U. A. Dutch* e exhibit hard seededness on ning.

lighly wrinkled varieties are racterised by a low starch/ tein ratio, low alcohol-insoluble ds (A.I.S.) and a high sugar tent, with a predominantly lose type of starch content. ooth-seeded varieties generally e a high starch/protein ratio, igh A.I.S. content and a com- atively low percentage of sugar. e starch in them is of both amy- e and amylopectin types, the er predominating in some of the ieties.

Wrinkled varieties differ from smooth ones in their ash and osphate contents and acid-base ance.

Anthocyanin pigment in pas- on fruit rind, by Pruthi, J. S., sheela, R. and Girdhari Lal, *Food Sci.*, (*Food Res.*), 1961, **26** , 385.—Detailed studies were ported on isolation and identifica- n of the pigments naturally curring in passion fruit rind *assiflora edulis* Sim.) From color sts, distribution number, paper romatography, sugar residue and sorption spectra, pelargonidin 3-glucoside reported in passion uit rind is about 1.4 mg. of the gment per 100 g. of the fresh aterial.

A study of the consumption ad production of packaging aterials in India, by Sreenathan, . R. and Iyengar, N.V.R., *Per- ctpac*, 1961 (*September-October*), —Tables provide quantitative formation on: (*i*) the total value of ackaging materials consumed by arious industries; (*ii*) value and uantity of different types of ackaging materials used by all in ll industries; (*iii*) consumption and v) production of different types of ackaging materials in India from 946 to 1956.

—K.M.D.

Processing of desiccated co- onut, by Rajasekharan, N., Pan- lalai, K. M., Bhatia, D. S. and Bhatia, B. S., *Indian Cocon J.*, 1962, **15** (2), 70.—Fully mature nuts give the best product and maximum yield when dehydrated in a through-flow drier at 70°C.

For maximum shelf-life the moisture content in the product should not exceed 2 per cent. Addition of antioxidants, compression or packing in an atmosphere of nitrogen does not improve the keeping quality any further. Medium grade commercial product has better keeping quality than fine grade product. Steaming the shredded nuts prior to dehydration decreases the development of F.F.A. on storage.

Cost data for the manufacture of desiccated coconut have been given.

Trends in coffee technology with increased production of coffee, by Subrahmanyan, V., Bhatia, D. S., Natarajan, C. P. and Majumder, S. K., *Indian coffee*, 1962, **26**, 21.—From the seed to the cup, coffee demands the unremitting attention of science. In this article a brief resume of the valuable work which the C.F.T.R.I. is doing with regard to storage, especially in the context of increased production is given.

Effects of B-vitamins on protein utilization from Rice-Legume dietaries by the growing rat, by Wagle, D. S., Mitbander, V. B. and Sreenivasan, A., *J. Nutr.*, 1962, **76**, 199.—The rice-legume diets typical of those consumed by a large section of low-income groups in India were prepared to contain 6.8 and 10.2 per cent of protein and fed to rats for 8 weeks.

Although the diets failed to support good growth in weanling rats, growth was appreciable with young adult rats, and was further improved by B-vitamin supplementation. There were significant reductions in plasma levels of histidine, methionine and threonine in the B-vitamin supplemented group. The amino acid analysis of the diets indicated that the 6.8 per cent protein diet was deficient in amino acids other than arginine and valine, whereas the 10.2 per cent protein diet was deficient in methionine, lysine and tryptophan.

Supplementation of the 10.2 per cent protein diet with the deficient amino acids improved the efficiency of protein utilization and additional B-vitamins at high or low levels further enhanced the effect. Amino acids supplementation of the diet also resulted in a greater decrease in liver lipids than occurred with the B-vitamins.

Incorporating egg albumen at a 2 per cent level resulted in marked gains in weight. The effects of B-vitamin supplementation were more pronounced with the basal diet than with the diet supplemented with egg albumen. These results were discussed in terms of amino acid requirements and amino acid-vitamin relationships.

Protein isolate from groundnut kernel, *Res. & Ind.*, 1962, **7** (4), 139.—Oilseed meals left behind after the extraction of oil from oilseeds can serve as a valuable source of protein for human consumption. Isolated vegetable proteins are 2-4 times as concentrated as the source itself. The article describes methods developed at the Central Food Technological Research Institute, Mysore, for processing of expeller groundnut cake and groundnut kernels for the isolation of protein.

Alkaline phosphatase formation in *Escherichia coli* vitamin B_{12}-/-methionine auxotroph, by Pradhan, D. S., Rege, D. V. and Sreenivasan, A., *Enzymologia*, 1962, **24**, 105.—Induction of alkaline phosphatase by phosphate starvation for 4 hours has been observed in *E. coli* 113-13 (vitamin B_{12} -/-methionine auxotroph). During this starvation period, the RNA content of the culture remains unchanged while protein, DNA and the viable count continue to increase.

There is no evidence for a genetic change in the organism as seen from the viable count on agar plates containing low and high concentrations of phosphate and from the observation that alkaline phosphatase can be induced in penicillin-inhibited cell division.

Formation of alkaline phosphatase show strict dependence on methionine concentration and is inhibited by chloramphenicol. 8-Azaguanine and 2-thiouracil do not inhibit alkaline phosphatase formation.

Inorganic phosphate inhibits activity of alkaline phosphatase, represses its further increase during growth, but does not induce degradation of alkaline phosphatase already present.

These observations are discussed in terms of a feed-back mechanism and the possible role of nucleic acids in enzyme biosynthesis.

Interrelationships between vitamin B_{12} and pantothenic acid in the rat in experimental thyrotoxicosis, by Aiyar, A. S. and Sreenivasan, A., *Indian J. med. Res.*, 1962, **50** (2), 262.—1. The rapid depletion of liver stores of vitamin B_{12} and soluble sulfhydryl in the hyperthyroid rats is accompanied by an increase in coenzyme A. Dietary supplements of vitamin B_{12} as well as of magnesium show appreciable protection against these changes.

2. Intraperitoneal administrations of vitamin B_{12}, and to a lesser extent 1-methionine, result in a return to normal of the elevated hepatic coenzyme A stores of the hyperthyroid rat, by the end of 72 hours.

3. An increased channelling of the sulfhydryl reserves of the cell into coenzyme A rather than into glutathione or methionine, as a physiological adaptation for greater energy production under the imposed stress condition is indicated.

The metabolism of nitrogen, calcium and phosphorus in children on a poor Indian diet based on maize (*Zea mays*), by Tasker, P. K., Doraiswamy, T. R., Narayana Rao, M., Swaminathan, M., Sreenivasan, A. and Subrahmanyan, V., *Indian J. Pediatr.*, 1962, **29**, 37.

1. The metabolism of nitrogen, calcium and phosphorus was studied in eight boys aged 9 to 10 years on a poor maize diet. The composition of the diet was similar to that consumed by the poorer classes of people in certain parts of the country.

2. All the experimental subjects maintained a positive nitrogen balance, the average daily intake and retention being 8.66 and 0.99 g. respectively. The loss of nitrogen in the faeces was very high (3.98g.) and the apparent digestibility of tl proteins was only 54.0 per cent.

3. The average daily intake ar retention of calcium were 0.382 and 0.067 gm. respectively. A the subjects maintained a positi calcium balance.

4. The average daily intake ar retention of phosphorus were 1.3 and 0.340 gm. respectively. A the subjects maintained a positi phosphorus balance.

Alterations in intestinal micr flora in the terramycin fed ra by Netrawali, M. S., Rege, D. V and Sreenivasan, A., *J. sci. indus Res.*, 1962, **21C** (2), 31.—Alter tions in morphological chara teristics and metabolic activities coliforms isolated from faeces of r fed terramycin over a long peri have been studied. Coliforms fro terramycin-fed group show tol ance to the antibiotic; those fro vitamins-supplemented group al exhibit tolerance though to a less degree. No noticeable effect *in vitro* addition of vitamins growth is observable. Colifor from antibiotic-fed group ha lower capacity to utilize pyruv and glucose; those from the gro fed the antibiotic with vitam show enhanced oxygen uptake w several tricarboxylic acid cy intermediates.

PART II (Indian)

ANALYTICAL

A new colorimetric method for the estimation of caffeine in beverages, by Jayaraman, K. S., Ramanujam, S. and Vijayaraghavan, P. K., *Curr. Sci.*, 1962, **31** (7), 282.—The method described in the note is based on the colour reaction given by tertiary amines with malonic acid and acetic anhydride which, it has been found from the preliminary studies employing various carboxylic acids and dehydrating agents, can be used for the quantitative estimation of caffeine in beverages.

At first caffeine (B.P.) is subjected to sublimation followed by drying at 100°C for 4 hours to yield any anhydrous caffeine which is treated with 2 per cent malonic acid solution in acetic anhydride. The mixture is heated on a waterbath, under anhydrous conditions at 85-90°C for ten minutes. The orange-yellow colour thus obtained is suitable diluted with methanol to get greenish yellow colour. This is measured with Hilger Biochem Absorptiometer using 430 m. filter and a half cm. cell. Beer's law is found to be obeyed in the concentration range of 10-50 mg. of caffeine per ml.

The method, after standardization, was employed for the estimation of caffeine in beverages l coffee, tea and coco cola. T results obtained are presented a agree fairly well with the report values.

—R.C.B.

BIOCHEMISTRY AND NUTRITION

Nutritive value of field be (*Dolichos lab lab*)**: Part I Effect of feeding raw field be on liver constituents and li enzymes of albino rats,** Kalindi Phadke and Kamala Sol nie, *J. sci. industr. Res.*, 19 **21 C** (8), 207.—The livers of r n raw field bean diet show a tion in glycogen, glutathione, and free riboflavin contents an increase in fat content. A ease in the activities of liver nes is also observed. Zonal sis of liver is observed in rats n raw field bean diet but not in fed autoclaved bean diet. e observations lead to the lusion that, apart from amino deficiency, there is an unknown r in the field bean which is nsible for liver necrosis and changes in liver constituents.

ponins and sapogenins: —XVI Echinocystic Acid n the seeds of *Albizzia ama-* enth. by Varshney, I. P. and nsuddin, K. M., *J. sci. industr.* 1962, **21 B** (7), 347.—The s of *A. amara* Benth. obtained Kerala yield, on alcoholic action, a saponin, which on rolysis gives an acid sapogenin. sapogenin has been identified chinocystic acid.

ffect of rice bran oil on lesterol metabolism in Al- o rats, by Rajalakshmi, S., na, D. S. R. and Sarma, P. S., *ci. industr. Res.*, 1962, **21 C** (7), —Rice bran oil has been found be effective in preventing the mulation of cholesterol in the ues of rats fed hydrogenated fat 25 per cent level. The mecha- n of action of rice bran oil ears to be similar to that report- or corn oil, in that it stimulates both synthesis and degradation of cholesterol.

Nutritive value of field bean (*Dolichos lab lab*): Part II—Effect of feeding raw, autoclaved and germinated beans on the growth of rats and nitrogen balance studies, by Kalindi Phadke and Kamala Sohonie, *J. sci. industr. Res.*, 1962, **21 C** (7), 178.—The effect of feeding raw and autoclaved field bean, casein and field bean mixtures and germinated and cooked field bean on the growth of young albino rats has been investigated. Raw field bean retards the growth of rats and ultimately leads to their death. The deleterious effect of feeding is more pronounced as the amount of field bean in the diet is increased. Autoclaving, germination or cooking does not overcome the growth inhibition of rats. Nitrogen balance studies indicate that biological value, true digestibility and net protein utilization of raw field bean are less than those of casein. These values are increased by autoclaving the pulse for 5 min. at 15 lb./sq. in. pressure, but the values are still lower than those for casein. Excretion of essential amino acids in the case of rats fed raw field bean is more than that of rats fed casein.

Nutritive value of field bean (*Dolichos lab lab*): Part III—Effect of supplementation of essential amino acids to raw and autoclaved field bean on the growth of albino rats, by Kalindi Phadke and Kamala Sohonie, *J. sci. industr. Res.*, 1962, **21 C** (7), 182.—The effect of feeding raw and autoclaved field bean supplemented with essential amino acids on the growth of rats has been investigated. Raw field bean does not support the growth of rats, even after supplementation with essential amino acids in which the pulse is deficient. The rats fed on diet containing field bean autoclaved for 5 min. and supplemented with essential amino acids show proper growth. The growth inhibition of rats fed on raw field bean does not appear to be due to either amino acid imbalance or antagonism. The presence of some heat labile growth inhibitor is, therefore, postulated.

A note on the proximate principles and some lipid components in colostrum as compared to mature milk of poor class South Indian women, by Prasannan, K. G., Rajan, R. and Ramanathan, M. K., *Indian J. Pediat.*, 1962, **29,** 265. 1. Colostrum and mature milk samples of poor class South Indian women were analysed for total protein, casein, lactose, fat and different lipid components such as free fatty acids, phospholipids and cholesterol. 2. The significance of the whey: casein ratio is discussed. 3. The data for different lipid components not available in the Indian literature for human colostrum and mature milk are presented.

PART III (Foreign)

ALYTICAL

umigant measurement: The orimetric determination of thyl bromide, by Theodore mas and Ronald A. Latimer, *J. ric. Fd. Chem.*, 1962, **10** (4), —Methyl bromide was deter- ned from air mixtures by orimetric titration using 35 ml. nples. The vapor was absorbed converted to inorganic bromide a caustic-alcohol solution and the mide determined colorimetrically. Samples containing 17 to 350 μg. were readily analysed in less than 1 hour. By a modification of the instrument, the limit of detection was lowered to 3 μg. per sample.

Colorimetric determination of procaine penicillin in premixes, by Stanley E. Katz and A. George Winnett, *J. Agric. Fd. Chem.*, 1962, **10** (4), 284.—A colorimetric method has been developed for determining procaine penicillin in premix materials. It is based upon the conversion by base of penicillins to penicilloic acids. The penicilloic acids yield penaldic acid derivatives and penicillamine when treated with mercuric ions. Penicillamine is oxidized to the disulfide by phosphomolybdic acid which is converted into molybdenum blue. The intensity of the blue color is proportional to the concentration of penicillin present. Laboratory prepared feed supplements showed average recoveries of 93.9 to 104.5 per cent of the theoretical with coefficients of variation ranging from 3.4 to 6.1 per cent. Commercial premixes showed average recoveries of 98.8 to 110.3 per cent of tag guarantees with coefficients of variation ranging from 2.8 to 4.3 per cent.

Determination of nitrofurazone in milk, by Gary E. Paar, *J. Agric. Fd Chem.*, 1962, **10** (4), 291.—A short, convenient, photometric procedure for the determination of nitrofurazone (5-nitro-2-furaldehyde semicarbazone) has been developed for use in residue analysis. By precipitation of milk protein with sodium tungstate and sulfuric acid, concentrations of the above nitrofuran derivative can be estimated down to the 0.5 p.p.m. level.

Rapid determination of non-fat dry milk solids in cereal bars by paper chromatography, by Charles H. Coleman, Welburne D. Johnson, William J. Pleticka and Chester Butnis, *J. Agric. Fd Chem.*, 1962, **10** (4), 293.—A paper chromatographic method for screening cereal bars for non-fat dry milk solids content reduces the 2 days required for the classical procedures to 2 hours. The method combines clean-up with migration of lactose in a water extract of cereal bars containing other contaminants. The mobile solvent is 85 ml. of acetone made up with water to 100 ml. Partitioning and clean-up are aided by impregnating the paper with 1 ml. of heavy petroleum oil made up with petroleum ether to 100 ml., after spotting and drying. Identification of spots on the developed chromatogram is restricted to lactose and dextrose, using Soxhlet's modification of Fehling's solution as a chromogenic reagent and heating for 5 minutes at 100° C. in an oven. Spots are yellow against a blue background; semi-quantitative estimates may be made of lactose or non-fat dry milk solids content. A ball-point pen line along both margins of the chromatographic paper automatically and permanently records the advancing solvent front.

Analysis of recovered natural orange essence by gas chromatography, by Wolford, R. W., Alberding, G. E. and Attaway, J. A., *J. Agric. Fd Chem.*, 1962, **10** (4), 297.—Concentrated natural orange essences, commercially recovered in aqueous solutions, have aided in investigations of the volatile flavor of citrus juices. Analyses of chemical components, obtained in organic extracts, were performed by programmed temperature gas chromatography (PTGC). Retention temperature studies of the chemical spectrum employing two principal stationary phases, DEGS and Carbowax 20M, supplied tentative identification and peak assignments for 43 compounds. Application of a subtractive type analysis where the carbonyl constituents were removed chemically, provided a less complex material for study. Improved PTGC resolution of the carbonyl-free essence facilitated additional peak assignments.

Estimation of methionine hydroxy analog in mixed feeds, by Edward L. Rohdenburg, *J. Agric. Fd Chem.*, 1962, **10** (4), 313.—An analytical procedure for the hydroxy analog of methionine, DL-α-hydroxy-γ-methylmercaptobutylic acid, is required for the control of this supplement in commercial poultry feeds. In the method described, the analog is extracted from the feed with dilute HCl and the clarified extract is assayed microbiologically with *Lactobacillus arabinosis*. The small amounts of the analog present in commercial feeds (0.05 to 0.10 per cent) have been successfully determined.

Determination of protein-bound glutamine and asparagine, by Tower, Donald B., Peters, Edmund L., and Wherrett, John R., *J. biol. Chem.*, 1962, **237** (6), 1861.—1. A set of procedures is described by which protein-bound glutamine, glutamic acid, asparagine and aspartic acid are liberated without modification from proteins or peptides and are determined quantitatively by specific assay methods.

2. The whole pancreas preparation, Viokase, is employed for enzymatic hydrolysis of the proteins of peptides, and the residues released into the hydrolysates are determined by assay with Clostridium per fringens L-glutamic acid decarboxylase, L-glutaminase and L-aspartic acid decarboxylase, and with guinea pig serum L-asparaginase.

3. Enzymatic hydrolysis of the peptides tested was complete, but hydrolysis of intact proteins varied between 50 and 80 per cent of the values expected on the basis of acid hydrolyses. For determination of protein residue composition, enzymatic hydrolysis values are corrected to 100 per cent hydrolysis, based on the acid hydrolysis values for total glutamic acid, total aspartic acid and total amide contents of the samples.

4. The validity of the procedure has been established by analyses of proteins and peptides of known composition and a comparison of the results with reported values obtained by other methods. Bovine insulin, bovine ribonuclease, lysozyme, β-lactoglobulin types A and B, N-L-glutaminyl-L-asparagine, ribonuclease S-peptide, and the decapeptide (residues 11 to 20) cleaved from ribonuclease S. peptide by tryptic digestion have been utilized for this purpose.

5. Data for several other proteins, the amide compositions of which are not established, have been included as examples from proteins of higher molecular weight, widely divergent glutamic acid, aspartic acid, and amide contents, or both, upon which to evaluate the versatility of the procedure. Wheat gliadin, hempseed edestin, rabbit skeletal muscle tropomyosin, bovine serum albumin, and porcine gastric mucosa pepsin are represented in this group.

ANTIOXIDANT

Dietary antioxidants as related to vitamin E function, by Krishnamurthy, S. and Bieri, J. G., *J. Nutr.*, 1962, **77** (3), 245.—1. Chicks were fed a basal diet deficient in vitamin E and biologically active selenium with supplements of synthetic antioxidants at varying levels.

2. The efficiency of the antioxidants in preventing exudative diathesis correlated with their apparent concentration in the tissues as determined by an *in vitro* lipid peroxidation test (thiobarbituric acid.) Ethoxyquin and DPPD were most active, butylated hydroxytoluene (BHT) and di-tertiary-butyl 4 methylphenol (DBPC) were intermediate, whereas nordihydroguairetic acid (NDGA) and 2, 5-ditertiary-amylhydroquinone (DAH) were inactive as tissue antioxidants.

3. The presence of the antioxidants in liver and their effect on lipid peroxidation was confirmed by parallel studies of the iron-catalyzed oxidation of the isolated liver lipid.

4. Inhibition of *in vitro* lipid peroxidation by dietary selenium was considerably greater than that from dietary tellurium or arsenic. These latter elements did not prevent exudates.

5. A direct correlation between the α-tocopherol content of liver and the degree of *in vitro* lipid peroxidation was found.

6. Experiments are reported which show that the slight lipid peroxidation detected in 'zero time' homogenates is formed during the homogenizing procedure.

7. The results indicate that the variation among antioxidants in their ability to substitute for vitamin E is due primarily to differences in their availability to the body and subsequent deposition in the tissues.

BIOCHEMISTRY AND NUTRITION

Urolithiasis in the rat: III. Effects of proteins, carbohydrate and phosphate on the occurrence of calcium citrate stones, by Robert Van Reen, *J. Nutr.*, 1962, **77** (2), 137.—A strain of rats, designated NMRI-D which has been derived from the Osborne-Mendel strain, has been found to be particularly susceptible to the formation of calcium citrate calculi in the urinary tract. These rats form many stones when fed a diet containing 15 per cent of casein and 4 per cent Hubbell, Mendel, Wakeman salt mixture with sucrose as the source of carbohydrate, but form no stones when the casein is increased to 30 per cent at the expense of sucrose. Supplementation of the 15 per cent casein diet with soyabean protein also eliminated uroliths; however, gelatin supplementation was not efficacious. In another experiment the basal casein diet was enriched with a level of phosphate that would be contained in 15 per cent of casein. Some reduction in the incidence of stones was observed but they were not eliminated. It is suggested that a complete protein is necessary for protection against stones. Considerably fewer calculi were formed when sucrose was replaced by dextrose or starch and none was formed with replacement by whole wheat flour.

The influence of varying levels of dietary protein, carbohydrate and fats in the nutrition of the rat, by Siedler, A. J., Rice, M. S., Maloney, Particia A., Lushbough, C. H. and Schweigert, B. S., *J. Nutr.*, 1962, **77** (2), 149.—The effects of varying levels of dietary protein, carbohydrate and fats on the nutrition of the rat over a 57-week feeding period were studied.

After the rats had received the test diets for 4 weeks, those fed diets containing 50 per cent of their calories as casein had superior rates of gain and utilization of crude calories as compared with rats fed diets containing either 20 or 80 per cent of their calories as casein. Lard or corn oil substituted at the expense of sucrose increased the caloric efficiency of rats fed the diets containing 50 or 80 per cent of their calories as casein.

No apparent differences in average serum cholesterol, average total serum poly-unsaturated fatty acids, and average liver cholesterol were noted between the dietary groups through the initial 22 weeks of this study. After 57 weeks, high levels of dietary casein tended to increase serum cholesterol and to decrease liver cholesterol. Substitution of lard at the expense of sucrose tended to increase serum cholesterol at the low and high dietary casein levels, and to increase total liver cholesterol at all dietary casein levels. Substitution of corn oil at the expense of sucrose tended to decrease serum cholesterol at the intermediate and high dietary casein level and to increase liver cholesterol at all dietary casein levels. The highest liver cholesterol values were obtained in the groups fed corn oil at the lowest dietary casein level. The average total poly-unsaturated fatty acids of the serum was increased in the groups fed the high level of casein plus either lard or corn oil.

No evidence of abnormal fat deposits was observed in any of the hearts and aortas from these animals.

Fate of butylated hydroxyanisole in man and dog, by Astill, B. D., John Mills, Fassett, D. W., Roudabush, R. L. and Terhaar, C. J., *J. Agric. Fd Chem.* 1962, **10** (4), 315.—To see if results in rats, rabbits and dogs at high dose levels justified extrapolation, the fate of butylated hydroxyanisole in man was studied. Further possible pathways were sought in dogs. Dogs excreted 60 per cent of a 350 mg. per kg. dose unchanged in the faeces within 3 days and the remainder in the urine largely as sulfate conjugates of BHA, *tert*-butylhydroquinone, and an unidentified phenol. Little glucuronide was formed. Procedures used for low doses levels in rats were applied to man, where 0.5 to 0.7 mg. per kg. yields in the urine less than 1 per cent of the dose as unchanged BHA, and 27 to 77 per cent as the glucuronide of BHA, mostly within 24 hours. No de-alkylation or hydroxylation was found. Small doses in man and large doses in rats and rabbits have similar fates, and extrapolation from these species is justified. Comparative metabolism studies are important for safety evaluation of additives, particularly if extension to man is permissible.

CEREALS

Non-protein-nitrogen in wheat flour doughs, by Lee, J. W., *J. Sci. Food Agric.*, 1962, **13** (6), 321.—When unyeasted wheat flour doughs were incubated for 24 h. at 30°, the dialysable nitrogen level rose from 19.4 to 35.7 mg./100 g. of flour. Concurrent increases in amino peptide and ammonia nitrogen were also observed. The addition of antibiotics to yeastless doughs markedly changed the pattern of the distribution of non-protein-nitrogen on incubation. It is believed that much of the increase in free ammonia on incubation arises from changes induced in the gluten proteins.

COFFEE

The biosynthesis of caffeine in the coffee plant, by Anderson Louise and Gibbs Martin, *J. biol. Chem.*, 1962, **237** (6), 1941. The xanthine base of caffeine is synthesized from the same precursors as are purines in all of the other systems which have been studied. The xanthine is converted to 7 (or 3)-methylxanthine and in turn, to theobromine and caffeine. The β-carbon atom of serine, the α-carbon atom of glycine, formaldehyde, formate, methanol and the methyl carbon atom of glycine, of methionine are active precursors of the N-1, N-3, or both methyl carbon atoms of caffeine. The primary effect of light is an enhancement of purine ring formation. The methyl carbon atom of methionine is not a precursor of the ureido carbons of caffeine.

EGGS

The fatty acid composition of egg yolk lipids in relation to dietary fats, by Skellon, J. H. and Windsor, D. A., *J. Sci. Food Agric.*, 1962, **13** (5), 300.—The fatty acid composition of egg yolk lipids resulting from controlled dieting with sunflower seed oil and maize oil has been investigated by gas-liquid chromatographic analysis with a β argon chromatograph. The results are compared with earlier work involving separation by fractional crystallisation and ester fractionation methods and differences in composition are noted. The effect of dieting on fatty acid content has been re-examined.

ENZYMES

Enzymic activity at low moisture levels and its relation to deterioration in freeze-dried foods, by Matheson, N. A., *J. Sci. Food Agric.*, 1962, **13** (4), 248.—Loss of glycogen occurred in two different model systems containing enzymes from meat, when they were stored at humidities comparable to those of freeze-dried foods. The losses were much greater in experimental samples than in controls in which the meat extract was either boiled or absent. The fall in glycogen is attributed to enzymic activity which seems to persist at 3 per cent moisture content and perhaps even lower. Enzymic activity at such moisture levels could explain the sensitivity of raw freeze-dried foodstuffs to moisture level during storage and the insensitivity of precooked freeze-dried products.

Physico-chemical properties of lactic dehydrogenase, by Millar, David B. S., *J. biol. Chem.*, 1962, **237** (7), 2135.— On the basis of data obtained from velocity ultra-centrifugation, approach to equilibrium sedimentation, and diffusion studies, it is concluded that crystalline fraction A of beef heart lactic dehydrogenase exhibits concentration-dependent association. The molecular weight of the monomer is 72,000. Association in concentrated solutions appears to involve dimers and trimers. The minimal molecular weight, calculated from amino acid analysis, is also, 72,000. The diffusion coefficient of the monomer is estimated to be 7.39×10^{-7} cm^2 per sec and the sedimentation coefficient to be approximately 5.5 S. The frictional ratio of the monomer is 1.04.

FISH AND MEAT

A study of the influence of selected preparation procedures on flavor and aroma of fish, by Ruth E. Baldwin, Dorothy Hussemann Strong and James H. Tomes, *Food Technol.*, 1962, **16** (7), 115.—Flavor and aroma scores for 3 fish species were not sufficientl altered by: (1) the presence of skin or of bone during baking, (2 cooking in hot fat to suggest practical ways of eliminating an undesirable flavor or aroma characteristics present.

Radiation-pasteurized shrim and crabmeat, by Dorothy J Scholz, Russell O. Sinnhuber Dorothy M. East and A. W Anderson, *Food Technol.*, 1962, **1** (7), 118.—The quality of shrim and crabmeat irradiated with pasteurization dozes of gamma radiation and stored at 38°F was determined by subjective evaluation chemical analysis, microbiologica examination for total numbers o surviving organisms and detection of pathogenic micro-organisms Quality determinations showed tha the storage life of crabmeat irradiated at 0.25 megarad was extended t 3-4 weeks, compared with 1 wee for unirradiated samples held a the same temperature. A dose o 0.50 megarad extended the shelf lif to 5 weeks. Shrimp irradiated a 0.50 and 0.75 megarad remained i good condition throughout th 18-week storage period; no viabl microorganisms were found, an production of decomposition products was slight as measured by th chemical tests. Extension of she life was threefold.

Taste-panel tests of the irradiated crabmeat and shrimp indicate that irradiation flavor decline during storage.

FROZEN FOODS

Frozen fruit pies, by Kulp, K and Bechtel, W. G., *Food Technol*

62, **16** (7), 104.—Time of freezing uit pies, up to 28 hours, had no ect on the quality of crust or ling. For rapid freezing, both w temperature and forced air culation are necessary. Frozen es should be stored at 0°F or be- w. At temperatures, above 0°F, iality deteriorated rapidly from aking of the crusts.

Determination of the surface axy substances of grapes, by udman, W. F. and Grancarevic, I., *J. Sci. Food Agric.*, 1962, **13** (4), 21.—Two quantitative methods r the determination of waxy ibstances on the surfaces of grapes e compared. These methods pplied to the varieties of grapes sed for drying in Australia gave the llowing results for total extract- ble waxy substances (μg./sq.cm.) iltanas 125-140, currants 111, ordos 178, Waltham Cross 107.

After-cooking blackening in otatoes. I.—Introduction and nalytical methods, by Hughes, . C., Ayers, J. E. and Swain, T., . *Sci. Food Agric.*, 1962, **13** (4), 224. -A description is given of the nalytical methods used to investi- ate the role that certain chemical actors (citric acid, ortho-phospho- ic acid, chlorogenic acid, total henols and iron) play in after- ooking blackening of potatoes. An bjective method for measuring the ntensity of discoloration in the ubers is also described.

After-cooking blackening in otatoes. II—Core experiments, y Hughes, J. C. and Swain, T., *. Sci. Food Agric.*, 1962, **13** (4), 29.—The distribution of the after- ooking blackening pigment within n individual tuber is correlated with the ratio of citric acid to hlorogenic acid. The role that ron, inorganic phosphate and pH play is less important in this case than that of the two organic acids; although the former three factors may play a larger part in determining the differences in level of blackening between tubers.

Protein denaturation in frozen fish. VI.—Cold storage studies on cod using the cell fragility method, by Love, R. M., *J. Sci. Food Agric.*, 1962, **13** (5), 269.—The cell fragility method was used to investigate the muscle of cod that had been frozen and cold-stored under various conditions. The results are compared with those obtained by the 'soluble protein' method, and the relationship between them is discussed.

MICROBIOLOGY

The assimilation of amino acids by bacteria: The relationship between glycerol and 'incorporation factor', by Gale E. F. and Folkes, Joan P., *Biochem. J.*, 1962, **83** (3), 430.

1. The incorporation of glycine carbon into the trichloroacetic acid-precipitable fraction of *Escherichia coli* KI, harvested in the early exponential stage of growth and pre-incubated for 30 min. in buffered saline, is stimulated 10 to 13 fold by 'incorporation factor' preparation. The response is linear with time for at least 2 hours.

2. Glycerol has little or no initial effect under these conditions, but stimulation develops during incubation and after a lag period of about 60 min., an initial concentration of 0.1 mM-glycerol gives a stimulation equivalent to that obtained with 'incorporation factor.' Higher concentrations of glycerol are not more effective.

3. When the washed cells are incubated with glycerol for 60 min. before the addition of glycine, incorporation of the latter is stimulated immediately on addition, and the response is linear.

4. Glucose gives an immediate stimulation of glycine incorporation but the effect decreases rapidly with time.

5. No breakdown product of glycerol has been found which has significant stimulatory action. A 'formin' preparation containing formic acid ester of glycerol is approximately three times as active as glycerol itself. Other glycerides are inactive.

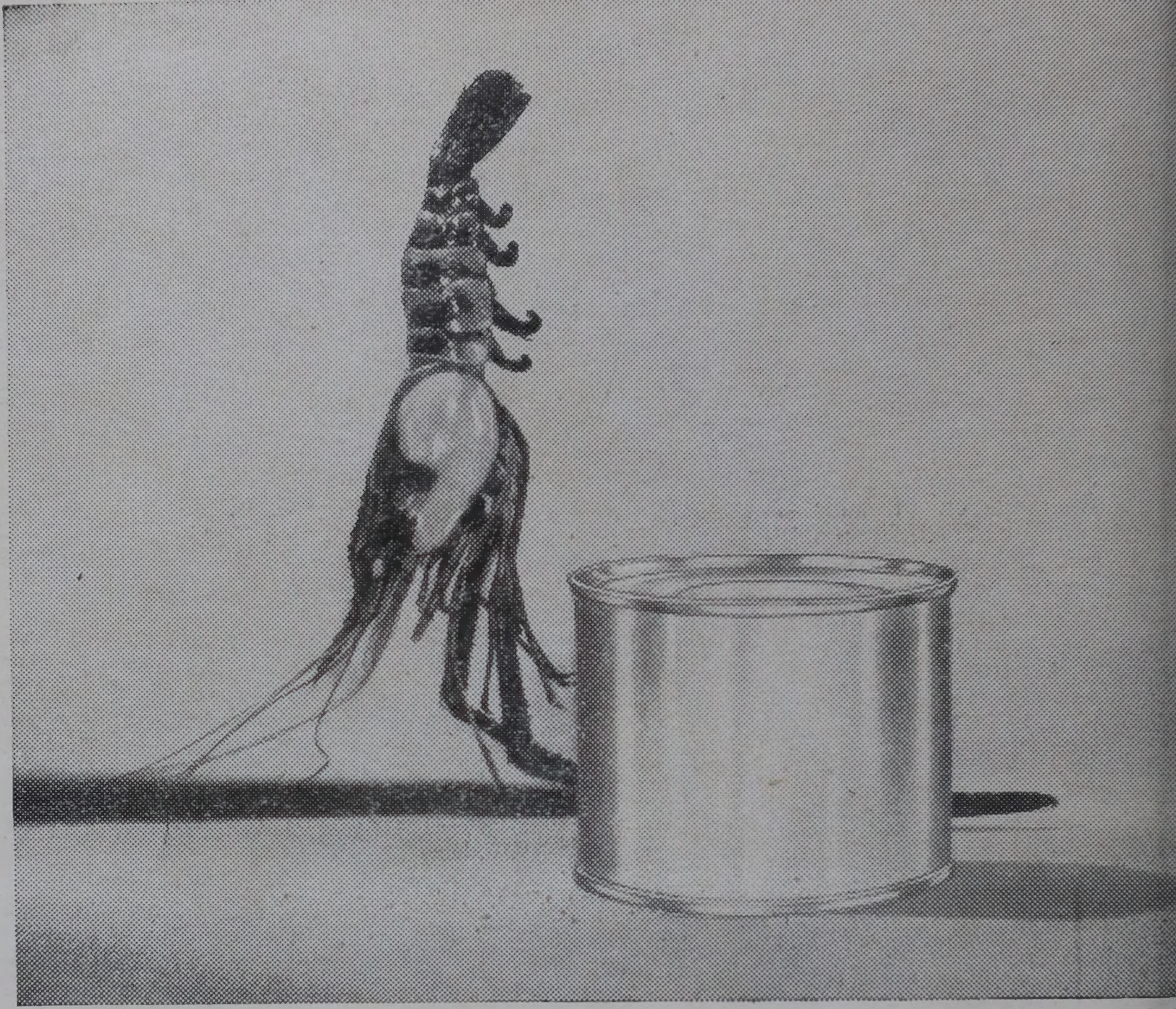
6. Glycerol is markedly less effective than 'incorporation factor' preparation, in promoting glutamic acid incorporation, under conditions of protein synthesis, in disrupted staphylococcal cells. Formin is again more effective than glycerol and, at a relatively high concentration, can replace 'incorporation factor' preparation.

The regulation of amino sugar metabolism in ***Bacillus subtilis,*** by Juliet S. Clarke and Pasternak, C. A., *Biochem. J.* 1962, **84** (1), 185.—1. Ultrasonic extracts of *Bacillus subtilis* contain the enzyme L-glutamine-D-hexose 6-phosphate aminotransferace (L-glutamine-D-fructose 6-phosphate amino-transferase, EC 2.6.1.16). The K_m for L-glutamine is 0.7 mM. and that for D-glucose 6-phosphate is 2.3 mM. It is inhibited 50 per cent by 10 μM-6-diazo-5-oxo-L-norleucine. In these and other respects it closely resembles the L-glutamine D-fructose 6-phosphate aminotransferase of *Escherichia coli.*

2. Ultrasonic extracts also contain low amounts of glucosamine 6-phosphate deaminase (2-amino-2-deoxy-D-glucose 6-phosphate ketol-isomerase, EC 5.3.1.10) which may be separated from L-glutamine —D-hexose 6-phosphate aminotransferase by precipitation with protamine sulphate.

3. Growth of *B. subtilis* in the presence of amino sugars causes repression of L-glutamine—D-hexose 6-phosphate amino-transferase and concomitant induction of glucosamine 6-phosphate deaminase.

4. The induction of glucosamine 6-phosphate deaminase is repressible by glucose.



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